Annual Progress Report

Lower Snake River Compensation Plan
Confederated Tribes of the Umatilla Indian Reservation
Evaluation Studies for 1 January to 31 December 1993

Section I
Evaluation of reestablishing natural production of spring chinook salmon in Lookingglass Creek, Oregon, using a non-endemic hatchery stock

Section II
Tribal harvest of spring chinook salmon in Lookingglass Creek, Oregon

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Assistance provided to LSRCP cooperators

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SECTION I

EVALUATION OF REESTABLISHING NATURAL PRODUCTION OF SPRING CHINOOK SALMON IN LOOKINGGLASS CREEK, OREGON, USING A NON-ENDEMIC HATCHERY STOCK

Abstract

This was the second year of a study to evaluate the reestablishment of natural production of spring chinook salmon in Lookingglass Creek using the non-endemic Rapid River hatchery stock. Ninety-nine adult Rapid River stock spring chinook salmon were released above the Lookingglass Hatchery weir in 1993. Age composition of fish released above the weir was 85% age 5, 12% age 4, and 3% age 3. Unmarked fish were preferentially selected for release above the weir, which appeared to have resulted in a higher proportion of five-year-old fish in the released group than that of the total return to the hatchery. Late installation of the weir allowed an estimated 217 adult chinook salmon to ascend to spawning grounds prior to weir installation.

During spawning surveys, we observed a total of 132 redds above the weir and 20 below the weir. Peaks in timing in the appearance of new redds in an index area above the weir on 16 and 23 August were about the same dates as peaks observed from 1966-1970 (17 to 21 August). Peaks in observations of live fish on 16 and 23 August were slightly earlier or about the same dates as peaks observed from 1966-1970 (21 to 15 August). The peak in the observations of dead fish on 29 August was about the same as peaks observed from 1966-1970 (30 August to 3 September).

Above the weir, the percentages of redds in areas closer to Lookingglass Hatchery were higher than those observed from 1966-1970, while the percentage in the area farthest from the hatchery was lower than during those years. Redd densities in the four areas above the weir in 1993 ranged from 4.7 to 11.9 redds per kilometer, generally around the middle of the ranges observed for these areas from 1964-1971.

We found a positive relationship between fork length and fecundity ($p < 0.05$) and a relatively good fit ($r^2=0.76$). The 1987 and 1988 cohorts of Rapid River stock appeared to have fewer four-year-old and more five-year-old fish than the 1968 and 1969 cohorts of the Lookingglass Creek stock.

Stream flows in the spring/summer were most similar to those which occurred in 1967, increasing March through mid-May, peaking at about 30 m^3/s. Flows decreased abruptly in late May and June, with flows about 2-3 m^3/s most of the remainder of the year. Peaks summer water temperatures in 1993 (13 °C) were generally lower and reached peak temperatures a few weeks earlier than those from 1964-1971 (16 - 18°C)

Introduction

The Grande Ronde River Basin historically supported large populations of fall and spring chinook (*Oncorhynchus tshawytscha*), sockeye (*O. nerka*) and coho (*O. kisutch*) salmon and steelhead (*O. mykiss*) (Nehlsen et al. 1991). Construction of hydroelectric facilities, over fishing, and loss of critical spawning and rearing habitat in the Columbia and Snake rivers basins, among other problems, produced large losses of chinook salmon and steelhead and extirpation of coho and sockeye salmon in the Grande Ronde River Basin (Nehlsen et al. 1991). Escapements of anadromous salmonids that have returned to the Grande Ronde River Basin (Oregon Department of Fish and Wildlife (ODFW) (unpublished data), as well as escapements to the entire Snake River Basin (Nehlsen et al. 1991), have declined, several to the point of extinction. As a result, the National Marine Fisheries Service (NMFS) listed fall chinook salmon as "endangered" and spring/summer chinook salmon as "threatened" under the federal Endangered Species Act of 1973 on 22 April 1992. Hatcheries were built in Oregon, Washington and Idaho to mitigate for losses of anadromous salmonids due to the construction and operation of the lower four Snake River dams under the Lower Snake River Compensation Plan (LSRCP). Lookingglass Hatchery on Lookingglass Creek (Figure 1), a tributary of the Grande Ronde River, was completed in 1982 and serves as the incubation and rearing site for the chinook salmon programs in Oregon under the LSRCP.

Since 1982, all adult spring chinook salmon captured at the Lookingglass Hatchery weir had been retained for broodstock with the exception of a few fish of Lookingglass Creek origin that returned in 1989. The upstream migration has been almost completely blocked by a picket weir located at the hatchery intake (Figure 1). Every year since the hatchery was constructed, some fish escaped above the weir as evidenced by redd counts during spawning surveys (ODFW, unpublished data). Since the release of a few spring chinook salmon of Lookingglass Creek origin in 1989, there had been no effort to release fish above the weir to spawn naturally.

This study was developed by the Confederated Tribes of the Umatilla Indian Reservation (CTUIR), the ODFW and the Nez Perce Tribe (NPT) to evaluate the potential for reestablishing natural production in Lookingglass Creek using Rapid River stock spring chinook salmon (Lofy et al. 1994). In 1992 and 1993, adults were placed above Lookingglass Hatchery in an attempt to initiate reestablishment of natural production above the hatchery weir. It was the opinion of fishery managers that if reintroduction of a non-endemic stock might be successful anywhere in the Grande Ronde River Basin, that Lookingglass Creek was a good location. Good quality habitat would provide an adequate opportunity for success, and the existence of the weir provided the ability to easily control adult escapement levels. A detailed historic database on the endemic stock from Lookingglass Creek (Burck 1993 and Burck 1964-1974) will allow comparisons of life history and production of the Rapid River stock to the endemic Lookingglass Creek stock.

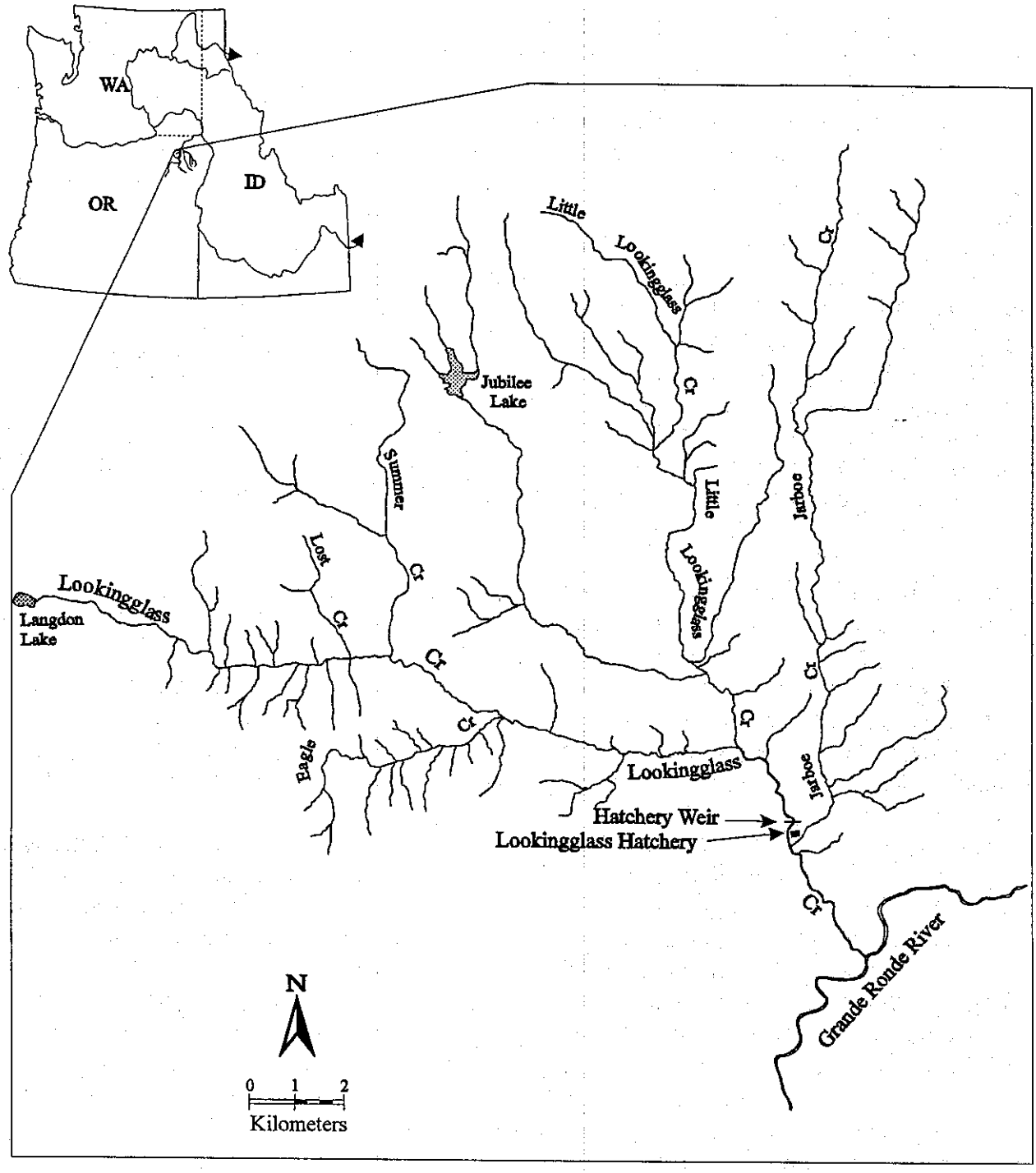

Figure 1. Map of the Lookingglass Creek basin.

The goal of this study is to determine the success of using a non-endemic hatchery stock for reestablishing natural production. We collected flow and temperature data from Lookingglass Creek to compare to data collected from 1964-1971. We also collected life history data on spring chinook salmon released above the weir in 1993 and compared it to data collected from 1964-1974 (Burck 1993 and Burck 1964-1974). Data from the historic database were used as a reference to evaluate aspects of the success of the reintroduction effort.

Study Area

The headwaters of Lookingglass Creek are located in the Blue Mountains of northeast Oregon at Langdon Lake, elevation 1.48 kilometers above sea level (Figure 1). Lookingglass Creek flows to the southeast approximately 24 river kilometers (rkm) through the Umatilla National Forest then through private land where it enters at approximately rkm 137 of the Grande Ronde River at an elevation of about 0.82 kilometers (Figure 1). Compared to other non-wilderness subbasins in the Grande Ronde River Basin, the fish habitat in the Lookingglass Creek basin has remained relatively undisturbed since 1974, with little logging and grazing occurring in the upper reaches of the system. Currently, most of the small scale logging and grazing operations occur on the privately-owned areas from about rkm 12.87 of Lookingglass Creek to the mouth. Clear cutting and recreational development occurred in the upper Lookingglass Creek and Little Lookingglass Creek basins from 1964-1974 (Burck 1993). Lookingglass Creek has three major tributaries, Eagle Creek (about rkm 13.27), Jarboe Creek (just below rkm 3.62), and the major tributary, Little Lookingglass Creek (just below rkm 6.48) (Figure 1). The hatchery weir is located at about rkm 4.02, and Lookingglass Hatchery complex is located at about rkm 3.62 (Figure 1).

Lookingglass and Little Lookingglass creeks were divided into four geographic units by Burck (1993) (Figure 2). Unit 1 extended from the mouth of Lookingglass Creek to Lookingglass Falls at rkm 4.02 (which is now the location of a picket weir and the hatchery water intake building). Unit 2 extended from the falls to the mouth of Little Lookingglass Creek located just below rkm 6.84. Unit 3 extended from the mouth of Little Lookingglass Creek to just above the mouth of Lost Creek at about rkm 17.70. Unit 4, which was Little Lookingglass Creek, started at the mouth and extended upstream to about rkm 6.43. We used these same units and landmarks in our study, but we divided Unit 3 into upper and lower sections at Young's cabin (Figure 2).

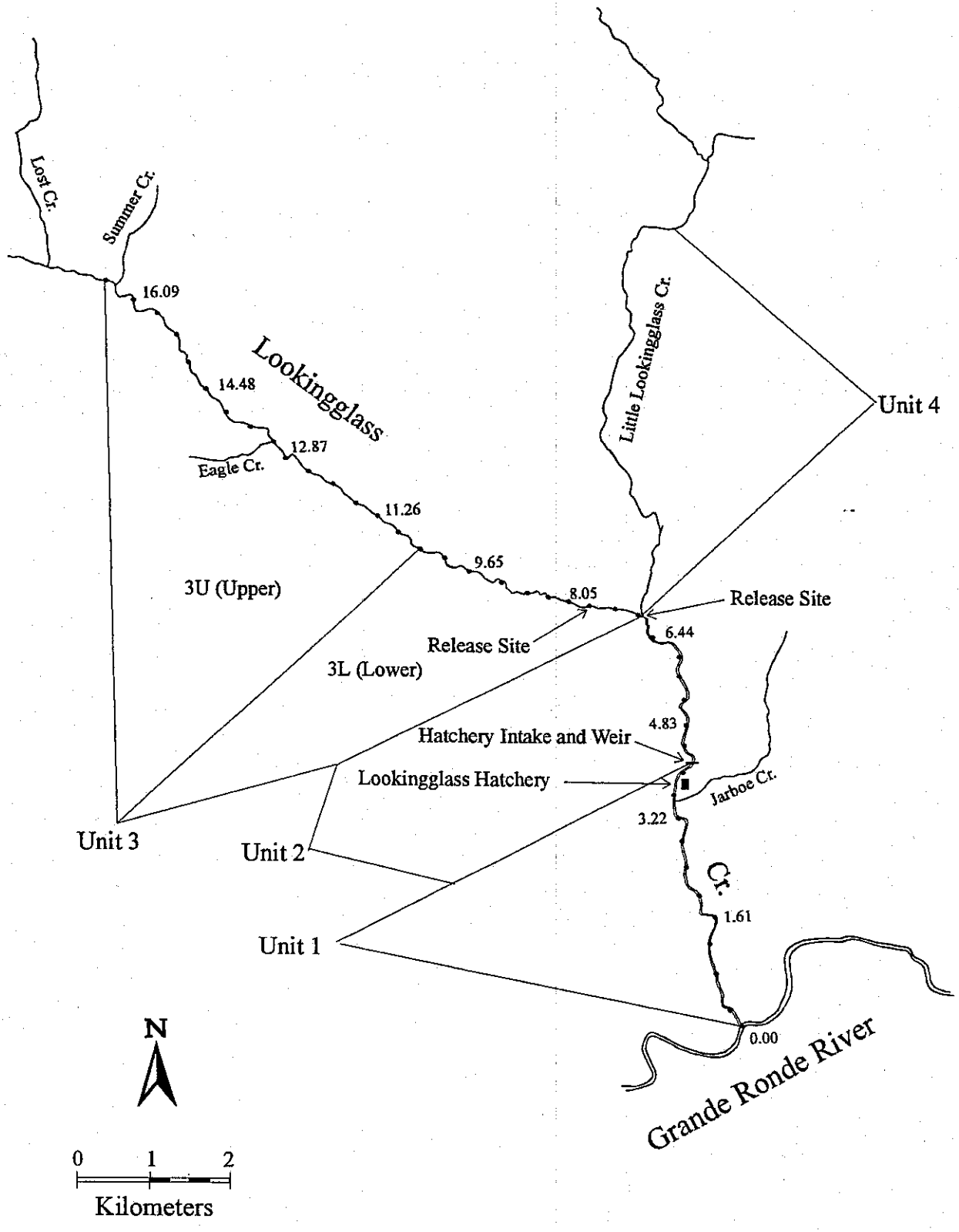

Figure 2. Locations of units and 0.4-riverkilometer sections (.) in Lookingglass Creek basin.

Methods

Stream Section Surveys

In order to reference sampling sites, Lookingglass Creek was surveyed in 1993 to reestablish ~0.4 rkm (0.25 rivermile) sections in approximately the same locations as those used from 1964-1974 (Burck 1993). Surveys were completed by measuring straight sections of the river and placing a marker about each 0.4 rkm. Surveys continued upstream to approximately rkm 16.89 (the upper limit of unit 3U). Markers from Burck (1993) still existed at rkm 5.23, 8.45 and 13.61. We adjusted our markers within three reaches (0.0 to 5.23, 5.23 to 8.45 and 8.45 to 13.61) to coincide with those remaining from the Burck (1993).

Stream Flow and Temperature

Stream flows in Lookingglass Creek were summarized to characterize flow profiles in the watershed from 1993 and compare them to those from 1964-1971 (Burck 1993). Stream flow data for each year were summarized by grouping available daily data into 52 periods which each corresponded to a week of the year. The maximum and minimum stream flow data that were available from 1964-1971 and during 1993 were determined for each of the 52 periods. For 1964-1971, stream flows were estimated only once daily and only when the stream was visited, which ranged from 3 to 27 days per month, averaging 15 days. Estimates of flow were made with gage heights (Burck 1993). Data for January to September 1993 were taken from Hubbard et al. (1994). Data for October to December 1993 were obtained from the United States Geological Survey (USGS) (unpublished data). Stream flows in 1993 were estimated every 0.5 hours at an electronic stream gaging station operated by the USGS. A mean daily stream flow was reported.

Stream temperatures in Lookingglass Creek were summarized to characterize temperature profiles in the watershed for 1964-1971 (Burck 1993) and for 1993. All water temperature data were summarized by grouping yearly data into ranges for each week of the year. Data for 1993 were from unpublished summaries from the United States Forest Service (USFS), Walla Walla District. Stream temperatures measured in 1993 were recorded about rkm 12.07 in Lookingglass Creek by the USFS, Walla Walla District. Temperatures were measured hourly with an electronic thermograph. A daily range in stream temperature was provided to us. Water temperatures for 1964 to 1971 were measured with a continuous-recording 7-day thermograph in Lookingglass Creek just upstream of the mouth of Little Lookingglass Creek at about rkm 6.84. The water from Little Lookingglass Creek did not influence the thermograph (Burck 1993).

Sampling and Release of Adults Above the Weir

The procedures outlined in the Annual Operations Plan for LSRCP hatcheries in Oregon for 1993 called for the release of 75 to 150 adult and 5 to 10 jack chinook salmon above the picket weir on Lookingglass Creek. The target composition of the release group was 47% adult male,

47% adult female and 6% jacks. Chinook salmon less than 600 mm in fork length were classified as jacks. The hatchery trap began operation on 28 May. Installation was much later than desired because permission from the National Marine Fisheries Service to install the weir and operate the trap was delayed due to permitting requirements under the Endangered Species Act. Fish captured in the trap were processed on a weekly basis. Preference was for unmarked fish to increase the probability of placing any naturally-produced fish above the weir. Fish were selected from across the run timing to the hatchery.

Sampling of the fish released above the weir was done to compare age and sex to the total return to the hatchery. All chinook salmon released above the weir were assigned a sex by hatchery personnel at trapping, measured (fork length to the nearest 5 mm), and had scale samples taken (3 or 4 scales from each side of the fish in the key scale area) for determination of age and origin. Age was defined as the number of years from egg deposition (e.g., 5-year-old fish in 1993 was deposited as an egg in 1988) and origin was determined by discriminant analysis of the scales by ODFW.

Fish were tagged to allow identification of individuals when they were observed on spawning surveys, recycled through the hatchery trap, or recovered as carcasses. Chinook salmon were tagged just below the dorsal fin with numbered, 22-mm diameter red and white Peterson disc tags. Fish were secondarily marked to determine sex assignment at release and for recognition as previously-handled fish. A small, round piece of the operculum was removed with a paper punch (operculum-punched). The fish were released just below the mouth of Little Lookingglass Creek or at the next bridge upstream (Figure 2, release sites).

Spawning Surveys

Prespawning surveys were scheduled two weeks before we expected to observe redds to document prespawning mortality that might not be observed after the spawning commenced. We began prespawning surveys 7-8 July, earlier than scheduled, in an attempt to index the chinook salmon that had escaped past the weir. Data collected during spawning surveys were more detailed than are done for most spring chinook salmon spawning surveys in Northeast Oregon (Appendix Table 1).

Weekly spawning surveys were conducted after the first redd was observed to document the distribution and timing of spawning activity, count live fish, and recover carcasses. Spawning surveys were also conducted to document the number of tagged fish that moved downstream below the weir. Weekly spawning surveys commenced on 3 August with observation of the first completed redd. A dig (initiation of redd-digging activity) was flagged and given a number on the date it was first observed. Occupation of the site by a chinook salmon was also recorded on the flagging the first date the dig was observed. Only new digs were flagged on each survey. Digs were categorized as incomplete or complete redds based solely on physical characteristics. That is, a redd was designated as incomplete even if it was occupied (there was a fish on or near the redd). If a redd was still considered incomplete at the end of the survey season, it was not

counted in the total number of complete redds for the year. A redd designated as incomplete was usually unoccupied and did not yet have a distinct depression and clean gravel tailout. A complete redd was often occupied by one or more chinook salmon and had a distinct depression and clean gravel tailout. Once a redd was designated as complete by a surveyor, it was included in the total redd count.

Marked and unmarked carcasses were sampled during spawning surveys or after collection from the picket weir at the hatchery intake. Marked carcasses were recovered to retrieve coded-wire-tag information from adipose-clipped fish, estimate the accuracy of the sex assignment by hatchery personnel, and estimate the number of fish that escaped above the weir that were never handled. Similar information was recorded for untagged chinook salmon carcasses along with scale samples. Some carcasses were too decomposed to collect scales, determine the sex, or record mark information.

Spawning Timing

Comparisons of observations of live and dead fish and newly completed redds were used to index spawning timing. Numbers seen at each survey date were expressed as a percent of the total observed for the year. To describe variation in spawning timing between the Rapid River stock and the Lookingglass Creek stock, indices of spawning timing for 1993 were compared to 1966-1970 (Burck 1967, 1968, 1969, 1970, 1971). The 1966-1970 surveys were used because the frequencies of the surveys were most similar to those during 1992 and 1993. From 1966-1970, unit 3 encompassed the primary spawning area and was used to describe the spawning timing in Lookingglass Creek (Burck 1993).

Because the weir was installed later than we had planned, we were concerned that we may have inadvertently affected spawning timing of fish above the weir by allowing all early-arriving adults to spawn naturally. We compared appearance of tagged and non-tagged adults on redds to determine if adults that passed the weir site before it was installed spawned at a different time than those which were placed above the weir after it was installed. We assumed that few of the untagged adults above the weir were fish that had passed the weir after it was installed. Although we know that the weir has never been 100% effective at preventing upstream migration (yearly ODFW surveys have documented redds above the hatchery every year), adult salmon that had spawned above the weir before 1992 were probably only able to traverse it under high-water conditions that were not present after the weir was installed in 1993.

Prespawning Mortality Index

In 1993, we determined prespawning mortality using the same methodology as that reported by Burck (1993). Only female carcasses collected during weekly spawning surveys which retained more than an estimated 10% of their eggs were considered prespawning mortalities. Because we changed our criteria for inclusion as a prespawning mortality to allow comparison to Burck (1993), the prespawning index calculated for 1993 was not comparable to that previously reported

for 1992 (Lofy and McLean 1995). We recalculated and reported the 1992 index using our new criteria. Our prespawning index was calculated as:

$$\frac{\textit{number of females} < \textit{90 \% spawned that were recovered during spawning surveys}}{\textit{total number of females that were recovered during spawning surveys}} * 100$$

Population Estimates for the Number of Fish Above the Weir

Estimates were made of the total number of chinook salmon that escaped above the weir because the weir has not been 100% effective at stopping all upstream migration, and a large portion of the run was thought to have passed the weir location before it was installed in 1993. Total male and female portions of the population above the weir were estimated with a mark-recapture technique (Brower and Zar 1977) using tagged and untagged carcasses. Only carcasses for which the presence of the operculum punch or Peterson discs could be determined were included among the tagged or the untagged carcasses used for population estimation. We made separate calculations of the number of male (which included jacks) and female chinook salmon above the weir because the ratios of marked to unmarked carcasses may be different between the sexes (Lofy and McLean 1995) and we needed a separate estimate for the number of females to calculate a female/redd ratio. Population estimates for male or female chinook salmon $N_{(m \text{ or } f)}$ above the weir were:

$$N = \frac{(M)(n)}{R} \qquad SEM = \sqrt{\frac{(M)(n)(M - R)(n - R)}{R^3}}$$

N = population estimate for the number of males or females above the weir
M = total tagged males or females not observed below the weir
n = total males or female carcasses recovered (tagged + untagged)
R = total tagged male or female carcasses recovered
SEM = standard error of the mean for the estimate of the number of males or females

The estimate of the total population above the weir was used with the total number of redds to calculate a fish/redd estimate above the weir. A females/redd estimate was also calculated.

Sampling Adult Chinook Salmon for Pathogens

Pre-spawning carcasses recovered on surveys and any carcasses that were recovered on the picket weir were sampled for various pathogens. Pathologists from ODFW (Fish Pathology, La Grande, Oregon) sampled the carcasses for *Renibacterium salmoninarum* (bacterial kidney

disease), *Ceratomyxa shasta* (whirling disease), aeromonad/pseudomonad bacteria (general septicemia) and *Yersinia ruckeri* (enteric redmouth disease). The data from ODFW are summarized in this report.

Fecundity Estimates

The fecundity of female Rapid River stock spring chinook salmon was estimated at Lookingglass Hatchery in 1993. Fecundity estimates will eventually be used to estimate the number of eggs deposited above the weir. The longest and the shortest among each group of nine females spawned were selected for fecundity sampling. Fork length, prespawning fish weight and ovary weight were measured. Two samples of approximately 100 eggs each were weighed and counted. The number of eggs/g was estimated for each sample. Eggs which appeared viable that remained in the body cavity or that fell on the floor were included in the fecundity estimate. Estimates of eggs/female were calculated with the formula:

$$Eggs/female = (Ovary\ weight\ (g) * \bar{X}\ eggs/g) + eggs\ in\ the\ body\ cavity\ or\ on\ the\ floor$$

Sampler variability was calculated as a percent:

$$(((larger\ sample\ eggs/g) / (smaller\ sample\ eggs/g)) - 1) * 100$$

Females with sampler variability greater than 5% were not used in the development of a regression equation because precision of the estimate was considered questionable. A regression equation was developed with fork length to predict fecundity.

Run Timing

Comparisons of run timing of Rapid River stock to Lookingglass Hatchery were made between the total return and the 1993 release group. Late installation of the weir precluded comparisons with the Lookingglass Creek stock and the total return of Rapid River stock in previous years. All run timing data were summarized as the percent of the total return to the collection facilities for each week of the year.

Age Composition

Age compositions of individual cohorts of chinook salmon were compared between the Lookingglass Creek stock and the Rapid River stock. Data for two complete cohorts were available for each stock. Data for the Lookingglass Creek stock was from the 1968 and 1969 cohorts (Burck 1972, 1973, 1974, 1975). These were the only cohorts for which data were complete and from which scales were taken from returning adults at the trap by Burck (1993). Data for the Rapid River stock was from the 1987 and 1988 cohorts (Messmer et al. 1992, 1994, in press).

Age composition of the release group was compared to that of the total return to Lookingglass Hatchery. This was done to determine if the fish that were released represented the total return that was captured at the hatchery trap. Age composition for each group was determined by scale analysis completed by ODFW.

Redd Distribution and Density

To describe whether the adult chinook salmon of Rapid River stock utilized spawning areas in a similar pattern to those which were used by the Lookingglass Creek stock, redd distribution for 1993 was determined and compared to redd distributions of 1964-1971 (Burck 1993). Data from Burck (1993) were summarized by graphing the maximum and minimum percentages for units 2-4 of total redds above the weir for 1964-1971. Since completion of the hatchery, the proportions of fish above and below the weir have been affected by retention of returning adults for artificial production. Therefore differences between 1964-1971 (Burck 1993) and 1993 in unit 1 were not comparable. We split unit 3 into upper and lower sections in 1993 to better describe this large unit (Figure 2).

Redd density in 1993 was compared to 1964-1971 (Burck 1993) for units 1-4 to characterize potential differences in intensity of utilization of the spawning areas. Redd density data (redds/kilometer) from Burck (1993) were summarized into ranges for 1964-1971 for each unit. Data points for 1993 were graphed for comparison.

Juvenile Production Performance

We tagged juveniles with a passive-integrated-transponder tag (PIT tag) to index migration timing and survival to Lower Granite Dam. We seined and tagged 1000 juveniles throughout the rearing area above and just below the weir in the fall (September) to compare juveniles from Lookingglass Creek to juveniles tagged in the fall by ODFW in other Grande Ronde River tributaries. We also tagged 900 migrants at a 1.52-m diameter rotary screw trap located near the hatchery to index potential differences between groups of fish that moved past the trap at different times of the year (i.e., late summer, fall, winter/spring). The screw trap was put into operation on 28 October to capture juvenile chinook salmon that were moving downstream. The target dates for tagging from the screw trap for fall were 15 September until 31 December. However, we didn't start tagging this group until the trap was installed in October. Tagging for the winter/spring group will begin 1 January, and will be reported in our next annual report.

Monthly sampling for juvenile chinook salmon in Lookingglass Creek was scheduled around the 20th of each month, similar to the target date for monthly sampling in Burck (1993). Fork lengths from about 50 juvenile chinook salmon was the goal of the sampling at each location. Burck (1993) described 4 locations where monthly samples were collected in Lookingglass Creek: an upper area, rkm 16.49 to 16.09; a standard area, rkm 7.64 to 7.24; a lower area, at rkm 0.00 to 0.40 and within Little Lookingglass Creek about 2.82 rkm from its mouth. Juveniles were also sampled at the bypass trap located at rkm 3.62 (near the present site of the hatchery intake). We

attempted to sample as close as possible to these locations with the exclusion of the lower area. No fish were found near the mouth, so we sampled fish in an area adjacent to the hatchery complex to represent a lower sample site. For our monthly sample at the rotary trap, we included fish captured from the 15th through the 25th of the month.

Results

Stream Flow and Temperature

During most of 1993, the flow in Lookingglass Creek was 2 to 3 m^3/s. Spring flows started increasing in mid-March, peaked at about 30 m^3/s in mid-May, and decreased dramatically in late May and June to summer/fall low flows below 5 m^3/s (Figure 3). Stream temperatures in 1993 peaked in late June and again in early August (Figure 3). The widest weekly temperature ranges occurred during the summer months.

Sampling and Release of Adults Above the Weir

We released 99 chinook salmon in 1993 which were assigned as 50 females, 46 males and 3 jacks. Fork length, sex, age, and origin were summarized (Table 1). Percentages for this release were 46% adult males, 51% adult females, and 3% jacks.

Spawning Surveys

Spawning surveys for 1993 began 7 July and ended 28 September. The first completed redds were observed about 9 August in all units. The last new redds were observed during spawning surveys in units 1, 2, 3L and 3U around 10 September and on 3 September for unit 4. One additional redd was noted on 7 October during stream section surveys in unit 1. Completed redds above the weir totaled 132, while those below the weir totaled 20.

We summarized fork length, sex, and age from carcasses recovered during spawning surveys and from the picket weir (Table 2). The accuracy of the sex assignment at the time of trapping by hatchery personnel was checked against the actual sex from internal inspection upon the recovery of carcasses. There were 49 previously tagged adult chinook salmon carcasses (tagged and/or operculum-punched at recovery) for which the sex could be positively identified (21 males and 28 females). No fish were incorrectly assigned a sex at the time of handling. Therefore no adjustment in the numbers of each sex that was released was completed.

Spawning Timing

Peaks in the number of new redds observed in unit 3 occurred on 18 and 25 August (Figure 4) and 26 August below the weir. The peak in the numbers of live fish observed in unit 3 occurred on 29 August (Figure 5) and 26 August below the weir. Peaks in carcass recovery in unit 3 occurred 16 August and 23 August (Figure 5) and 3 September below the weir. Tagged and untagged fish appeared on redds at about the same time (Figure 6).

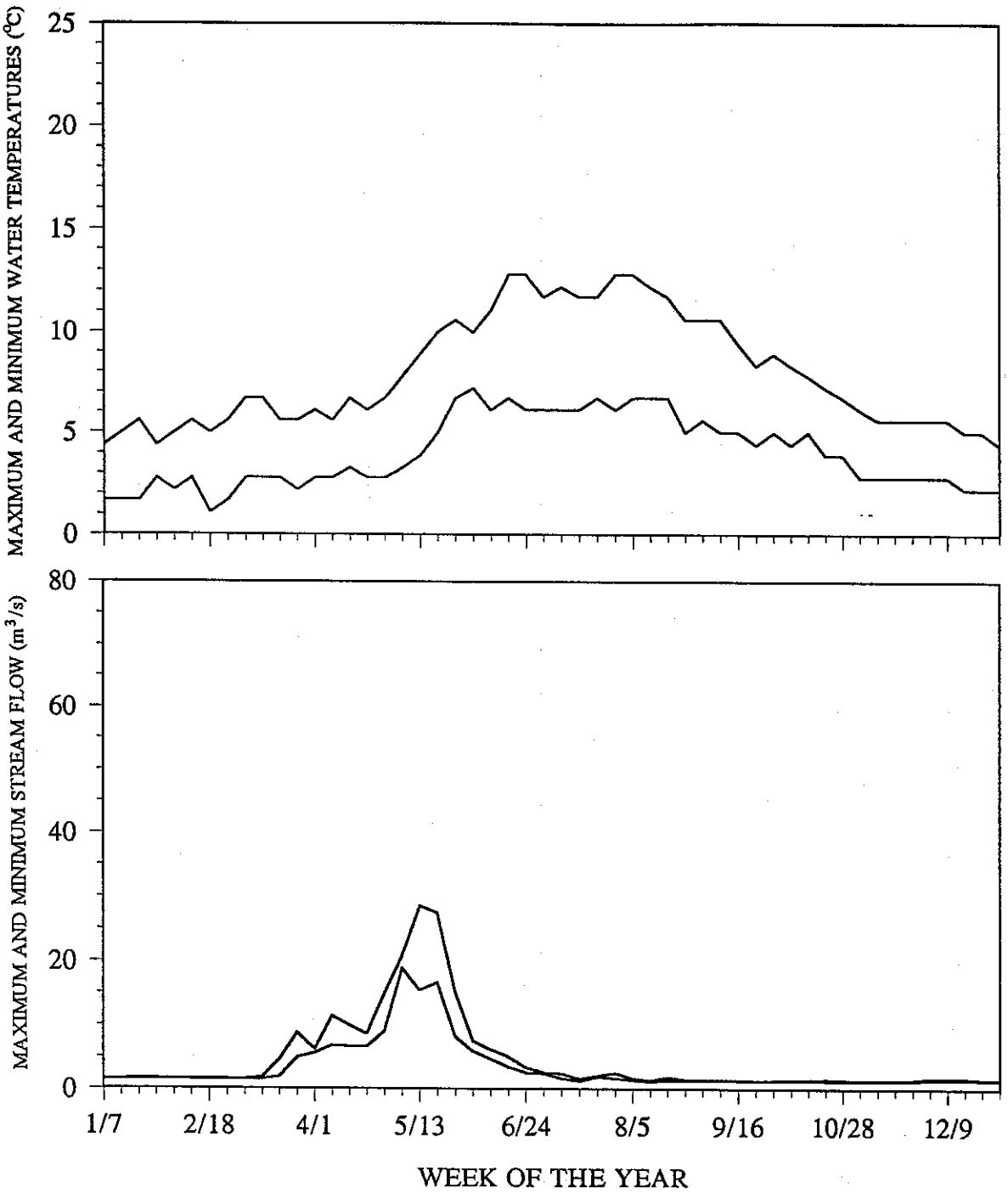

Figure 3. Weekly stream temperatures and flows for Lookingglass Creek in 1993 (Hubbard et al. 1992, and unpublished data). Flow data are a weekly range of 48 daily flows measured at a stream gaging station. Temperature data are a weekly range of 24 daily temperatures taken about riverkilometer 12.07. The weekly periods end on the dates shown.

Table 1. Origin, age, assigned sex, and fork length information from disc-tagged spring chinook salmon released above the weir on Lookingglass Creek in 1993.

		Males[a]					Females[a]				
				Fork Length (mm)					Fork Length (mm)		
Origin[b]	Age	#	%[c]	Range	Mean	± SD	#	%	Range	Mean	±SD
Hat	3	2	2.0	490	---	---	---	---	---	---	---
Unk	3	1	1.0	445	---	---	---	---	---	---	---
Hat	4	6	6.1	660-838	769.7	61.3	4	4.0	680-880	767.5	74.0
Unk	4	1	1.0	660	---	---	1	1.0	835	---	---
Hat	5	35	35.4	745-930	883.9	49.9	37	38.4	710-960	828.2	53.3
Unk	5	4	4.0	715-970	872.5	99.7	8	8.1	810-890	851.9	30.7

a The sex of the fish was assigned at the time of tagging.

b Origin of the fish, Hat = hatchery, Nat = natural, Unk = unknown. The origin was determined using scales from individual fish and applying a discriminant scale model (ODFW, unpublished data) for that return year.

c Percent of the total released.

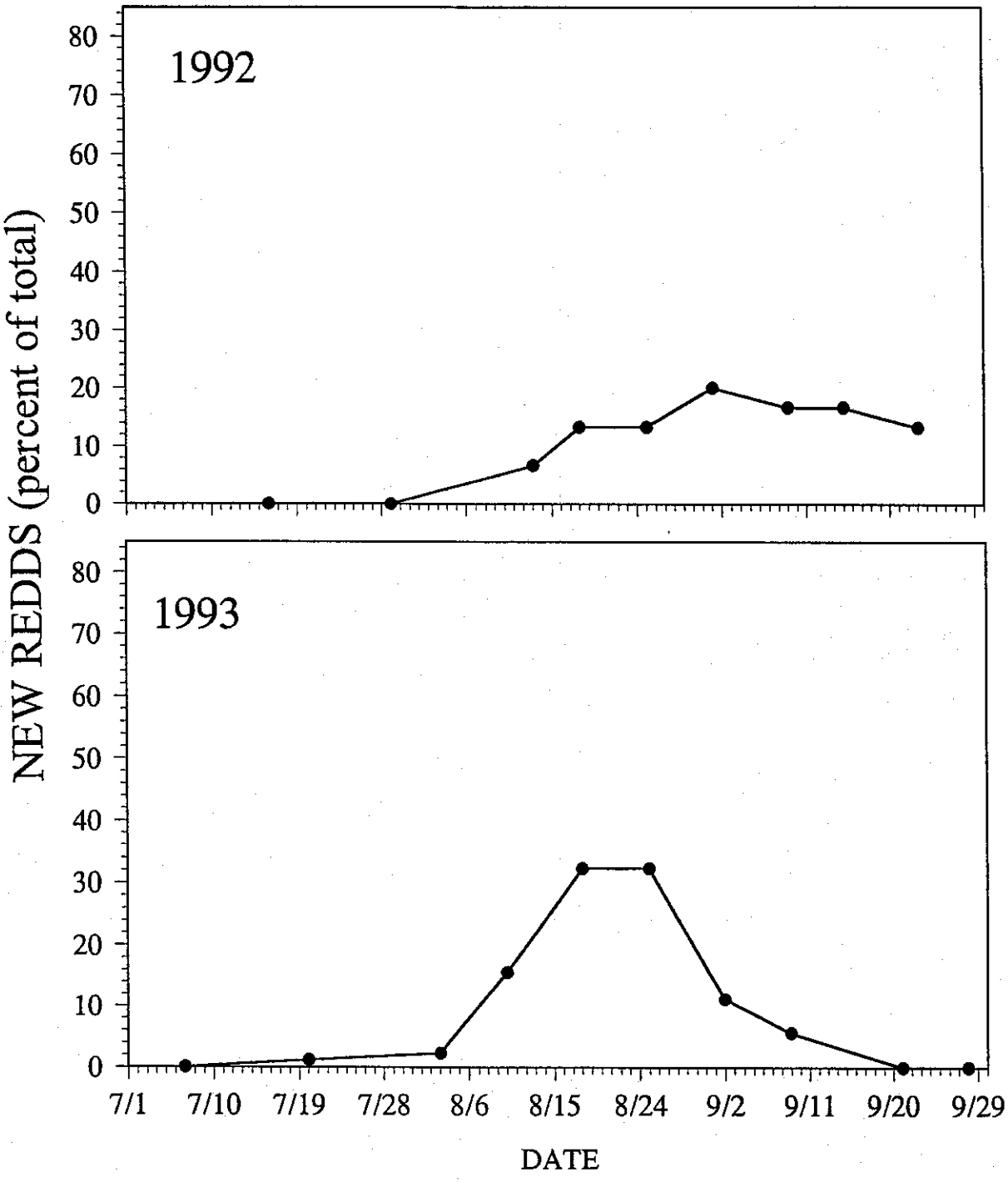

Figure 4. Percent of new redds seen on each survey date of the total number of redds observed in unit 3 of Lookingglass Creek for 1992 and 1993.

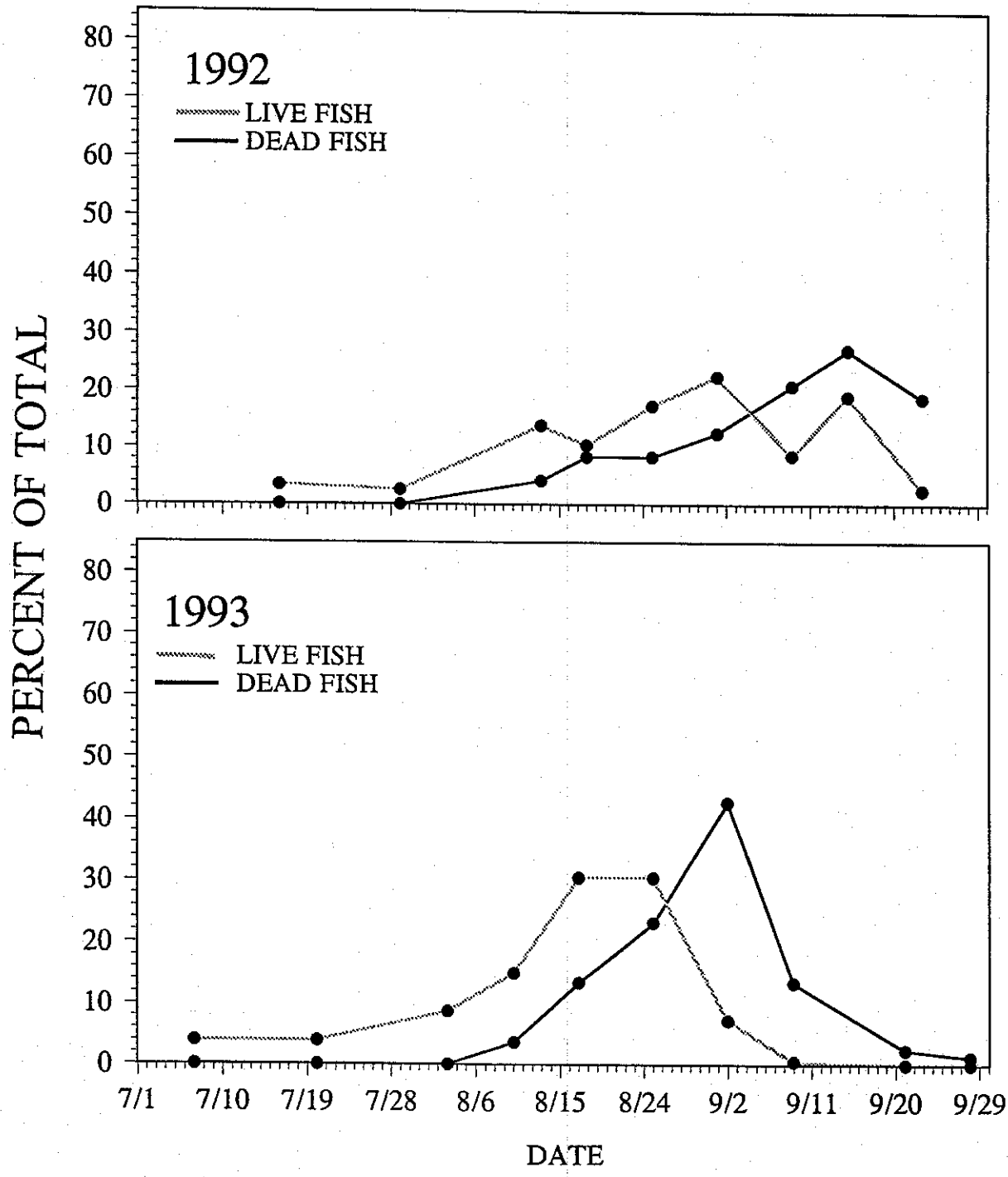

Figure 5. Percent of live or dead fish seen on a survey date of the total observations of fish in unit 3 of Lookingglass Creek for 1992 and 1993.

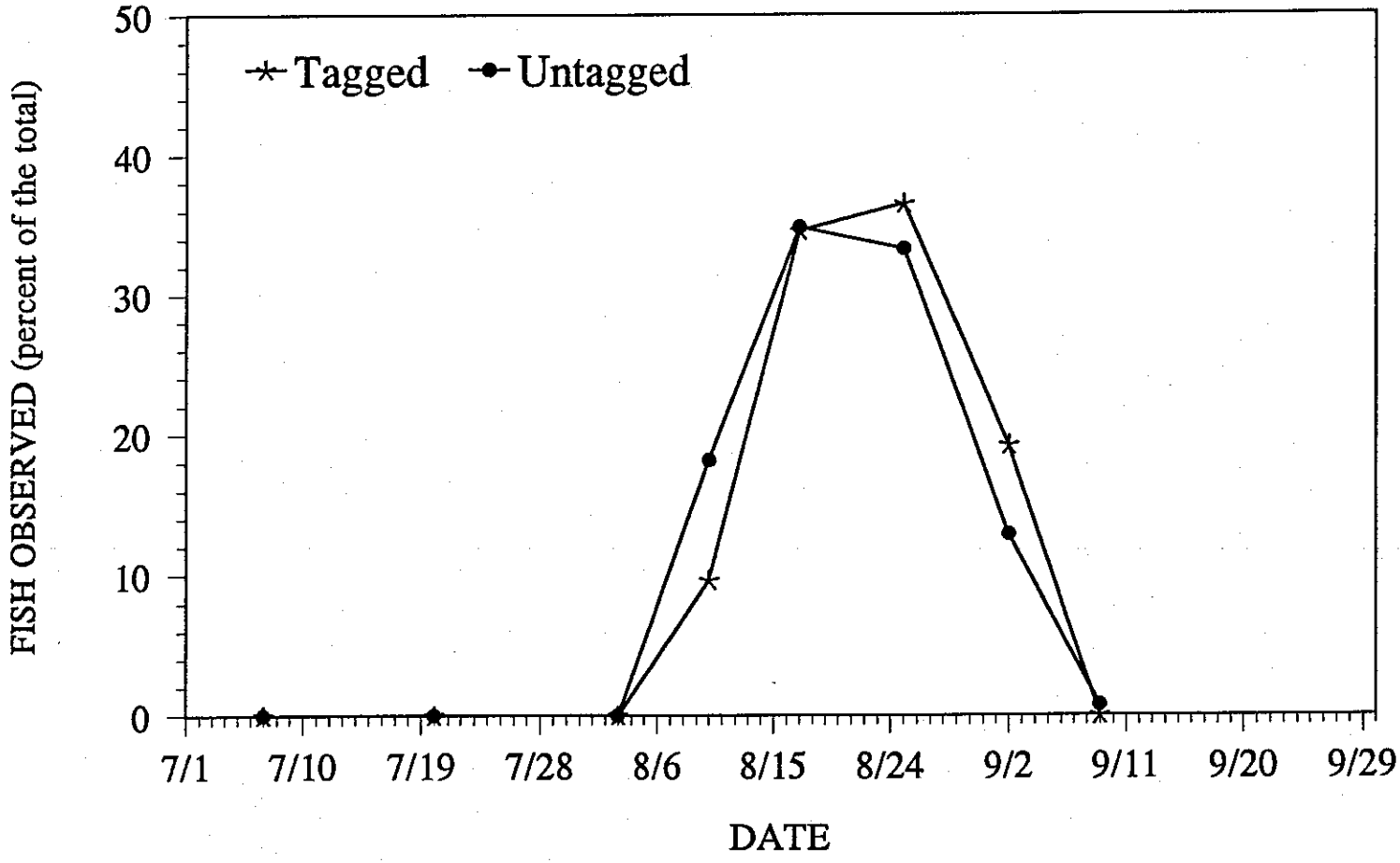

Figure 6. Percent of the tagged and untagged fish seen on a survey date of the total observations in Lookingglass Creek in 1993.

Table 2. Origin, age, sex at recovery, and fork length information from spring chinook salmon recovered on Lookingglass and Little Lookingglass creeks during spawning surveys or at the picket weir in 1993.

		Males[a]					Females[a]				
				Fork Length (mm)					Fork Length (mm)		
Origin[b]	Age	#	%[c]	Range	Mean	± SD	#	%	Range	Mean	±SD
Hat	3	3	1.9	460-500	483.3	17.0	---	---	---	---	---
Nat	3	2	1.3	490-610	550.0	60.0	---	---	---	---	---
Hat	4	9[d]	5.9	715-805	770.0	28.8	20	13.1	660-880	728.8	52.8
Nat	4	2	1.3	750-770	760.0	10.0	3	1.9	650-790	733.3	60.2
Unk	4	1	0.7	710	---	---	6[e]	3.9	670-835	735.0	56.4
Hat	5	31	20.3	720-1050	880.0	63.7	57	37.3	740-960	837.5	44.3
Nat	5	3	1.9	910-1025	961.7	47.7	1	0.7	805	---	---
Unk	5	5	3.3	920-990	955.0	23.1	10	6.5	750-890	824.0	36.5

a The sex of the fish was assigned at the time of tagging.

b Origin of the fish, Hat = hatchery, Nat = natural, Unk = unknown. The origin was determined using scales from individual fish and applying a discriminant scale model (ODFW unpublished data) for that return year.

c The percent of the total recovered upon which both age and sex could be determined. Twenty fish with unknown age were not included.

d Sample size for fork length was 8.

e Sample size for fork length was 5.

Prespawning Mortality Index

Prespawning mortality index was 11.1% for tagged females (N=27). The index was 5.1% for untagged females (N=78). The overall prespawning mortality index was 6.7% (N=105).

Population Estimates for the Number of Fish Above the Weir

Forty-nine males were placed above the weir and three of these were recovered below the weir for an estimated 46 marked males above the weir. Forty-five unmarked males were recovered above the weir. The total number of males above the weir was estimated to be 147 (Table 3). Fifty females were placed above the weir and 3 of these were recovered below the weir for an estimated 47 marked females above the weir. Seventy-eight unmarked females were recovered above the weir. The total number of females above the weir was estimated to be 169 (Table 3). There were an estimated 2.39 fish/redd and 1.28 females/redd above the weir.

Sampling Adult Chinook Salmon for Pathogens

Personnel from ODFW Fish Pathology laboratory were provided with 14 chinook salmon carcasses in 1993. Eight chinook salmon that were sampled had clinical infection levels of *Renibacterium salmoninarum* (bacterial kidney disease, BKD), although the antigen of the pathogen was present in all of the fish sampled (Table 4). Of the 13 fish sampled for *Ceratomyxa shasta* (whirling disease), seven had low to high infection levels (spores were present) and six were negative (Table 4). Aeromonad-pseudomonad bacteria (general septicemia) were found in 5 of the 14 fish sampled. *Yersinia ruckeri* (enteric redmouth disease) were found in 4 of the 14 fish sampled.

Fecundity Estimates

Seventy-four adult female Rapid River stock spring chinook salmon were sampled for fecundity in 1993. A regression model of fork length to predict fecundity was developed using only data with a sampler variability $<5\%$ (N=68) (Figure 7). The sample contained 35 five-year-old and 33 four-year-old females. The relationship had a positive slope, $P \leq 0.05$, and $r^2=0.76$.

Run Timing

Run timing of the total return in 1993 of Rapid River stock to Lookingglass Creek was not comparable to those of the Lookingglass Creek stock. The early part of the run did not appear to have been captured (Figure 8). It appeared, however, that we took fish for release above the weir in similar proportions to that of the total return (Figure 8).

Table 3. Population equation variables and estimates for the number of adult spring chinook salmon above the weir on Lookingglass Creek in 1993.

MALE

M_m = # of tagged males placed above the weir - # male carcasses observed below the weir
$M_m = 49 - 3$
$M_m = 46$

$n_m = 66$

$R_m = 21$

$N_m = (46*66)/21$

$$SEM_m = \sqrt{\frac{(46)(66)(46-21)(66-21)}{21^3}} \qquad SEM_m = 19$$

N_m = 147 total male chinook salmon population above the weir

FEMALE

M_f = # of tagged females placed above the weir - # female carcasses observed below the weir
$M_f = 50-3$
$M_f = 47$

$n_f = 108$

$R_f = 30$

$N_f = (47*108)/30$

$$SEM_f = \sqrt{\frac{(47)(108)(47-30)(108-30)}{30^3}} \qquad SEM_f = 16$$

N_f = 169 total female chinook salmon population above the weir

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Table 4. Results of analyses by ODFW Fish Pathology for pathogens of adult spring chinook salmon recovered above the weir on Lookingglass Creek in 1993.

Dates sampled	*Renibacterium salmoninarum* ELISA OD[a]	*Renibacterium salmoninarum* Infection level	*Ceratomyxa shasta* Infection level[b]	Aeromonad-pseudomonad bacteria[c]	*Yersinia ruckeri* (ERM-1)[c]
08/02	2.166	Clinical	Low	+	-
10/07	0.249	Low	High	+	-
10/07	2.797	Clinical	Moderate	0	+
10/07	0.950	High	Negative	0	-
10/07	0.446	Moderate	High	+	-
10/07	2.371	Clinical	Low	0	-
10/07	2.594	Clinical	Negative	0	+
10/07	2.341	Clinical	Negative	0	-
10/07	2.301	Clinical	Negative	0	-
10/07	0.362	Low	Negative	+	-
10/07	0.135	Low	Negative	0	-
10/07	2.521	Clinical	ND	0	+
10/07	2.238	Clinical	Moderate	0	+
10/07	0.187	Low	Low	+	-

a ELISA = Enzyme-linked immunosorbent assay; OD=optical density.

b ND = analyses not done. Low, Moderate or High = *C. shasta* spores were observed.

c + = found, in pathologically significant concentrations; 0 = not found in pathologically significantly concentrations; - = not found.

Age composition

Age compositions of the 1968 and 1969 cohorts appeared to have been different from those of the 1987 and 1988 cohorts (Figure 9). The Rapid River stock appeared to have a smaller percentage of jacks (2.0-7.1%) than the Lookingglass Creek stock (11.2-17.5%). The percentage of 4-year-olds of the Rapid River stock (50.5-60.2%) appeared to have been smaller than those of the Lookingglass Creek stock (74.8-86.9%). The percentage of 5-year-olds of the Rapid River stock (37.8-42.4%) appeared to have been much larger than those of the Lookingglass Creek stock (1.9-7.9%) (Figure 9).

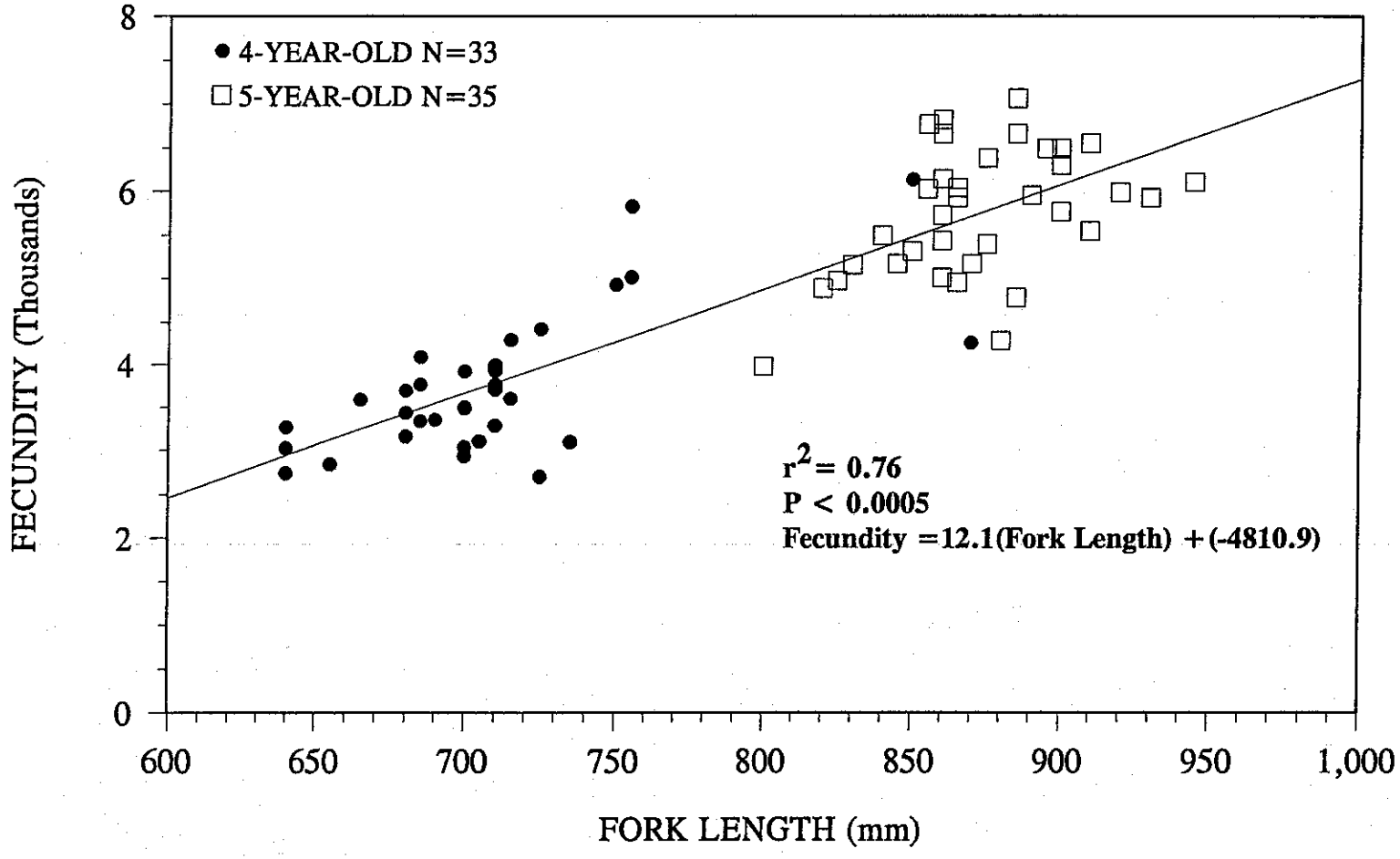

Figure 7. Relationship between fork length and fecundity estimates for Rapid River stock spring chinook salmon at Lookingglass Hatchery in 1993.

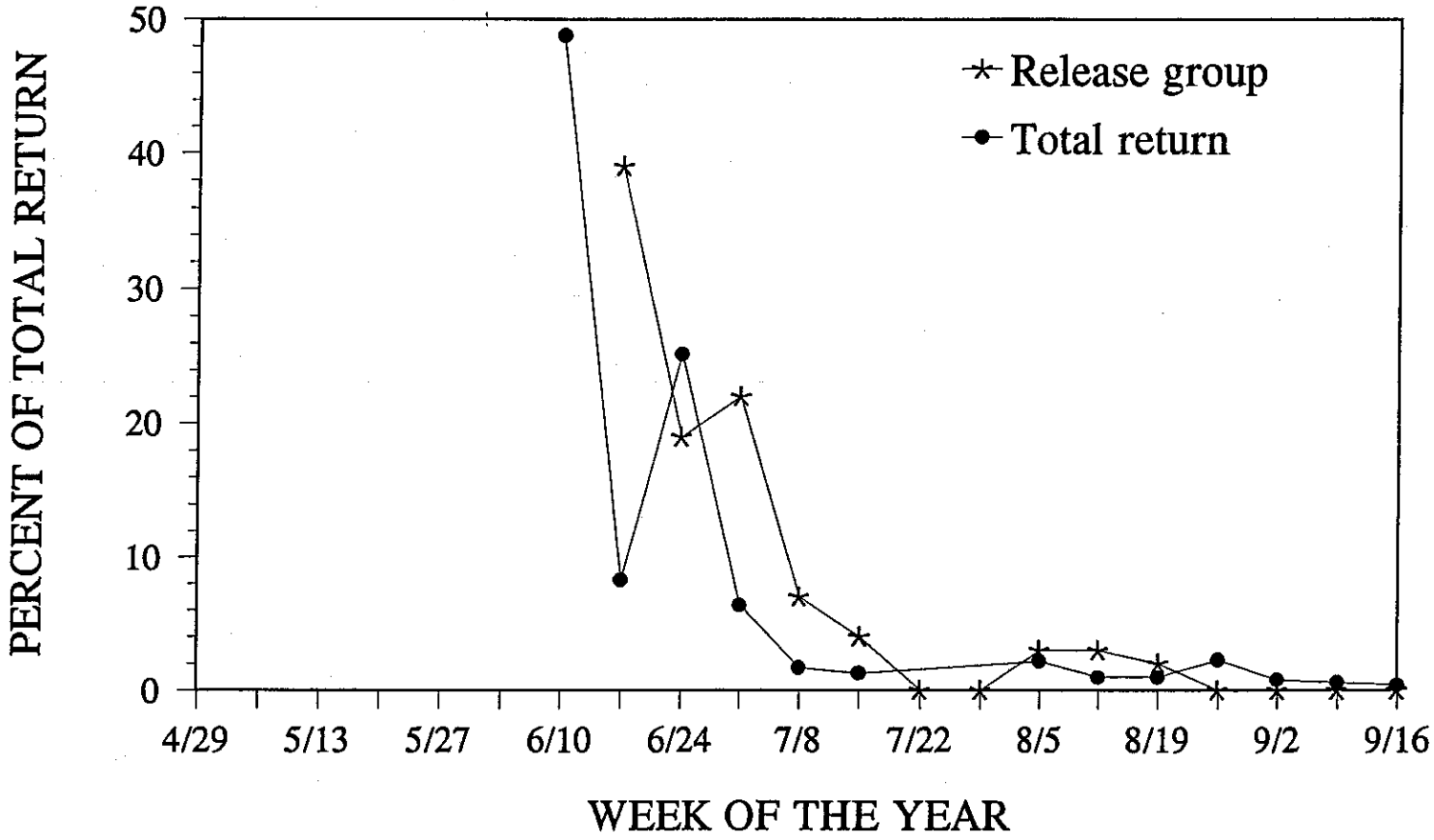

Figure 8. Run timing of spring chinook salmon to Lookingglass Hatchery for the total return and for the release group in 1993. The weekly periods end on the dates shown.

Age composition of Rapid River stock chinook salmon which were released for natural production was dissimilar to that observed for the total return (Figure 9). The percentage of 4-year-olds released into Lookingglass Creek was 12.0% while that of the total return was 31.9%. The percentage of the 5-year-olds released was 85.0% while than of the total return was 65.9%. The percentages of jacks placed above the weir were both about 2 to 3%.

Redd Distribution and Density

In 1993, 9% of total redds counted above the weir were in unit 2, 37% were in unit 3L, 31% were in unit 3U and 23% were in unit 4 (Figure 10). Densities of redds observed from 1964-1971 ranged from 3.0 to 22.9 redds/kilometer in unit 1, 0.4 to 7.0 in unit 2, 5.7 to 20.6 in the unit 3L, 8.1 to 21.6 in unit 3U and 1.9 to 7.0 redds/kilometer in unit 4 (Figure 10). In 1993 the redds/kilometer in units 1, 2, 3L, 3U and 4 were 5.0, 5.0, 11.9, 5.8, and 4.7 redds/kilometer, respectively (Figure 10).

Juvenile Production Performance

We PIT-tagged 1022 juvenile chinook salmon in Lookingglass Creek from 22 to 29 September in the rearing areas above and just below the weir. We were able to complete monthly sampling in the creek through November. We were not able to catch any fish in December due to their apparent scarcity. We obtained samples at the screw trap through December. Mean fork lengths of fish captured in the creek were 83.4 mm in September, 89.7 mm in October, and 89.5 mm in November (Figure 11). Mean fork lengths of fish captured in the rotary screw trap were 88.3 in October, 87.3 mm in November, and 87.0 mm in December (Figure 11). We PIT-tagged 935 juvenile chinook salmon from October 29 until 31 December at the rotary screw trap. Mean fork lengths of fish captured in the trap didn't vary much over the capture periods (Figure 12).

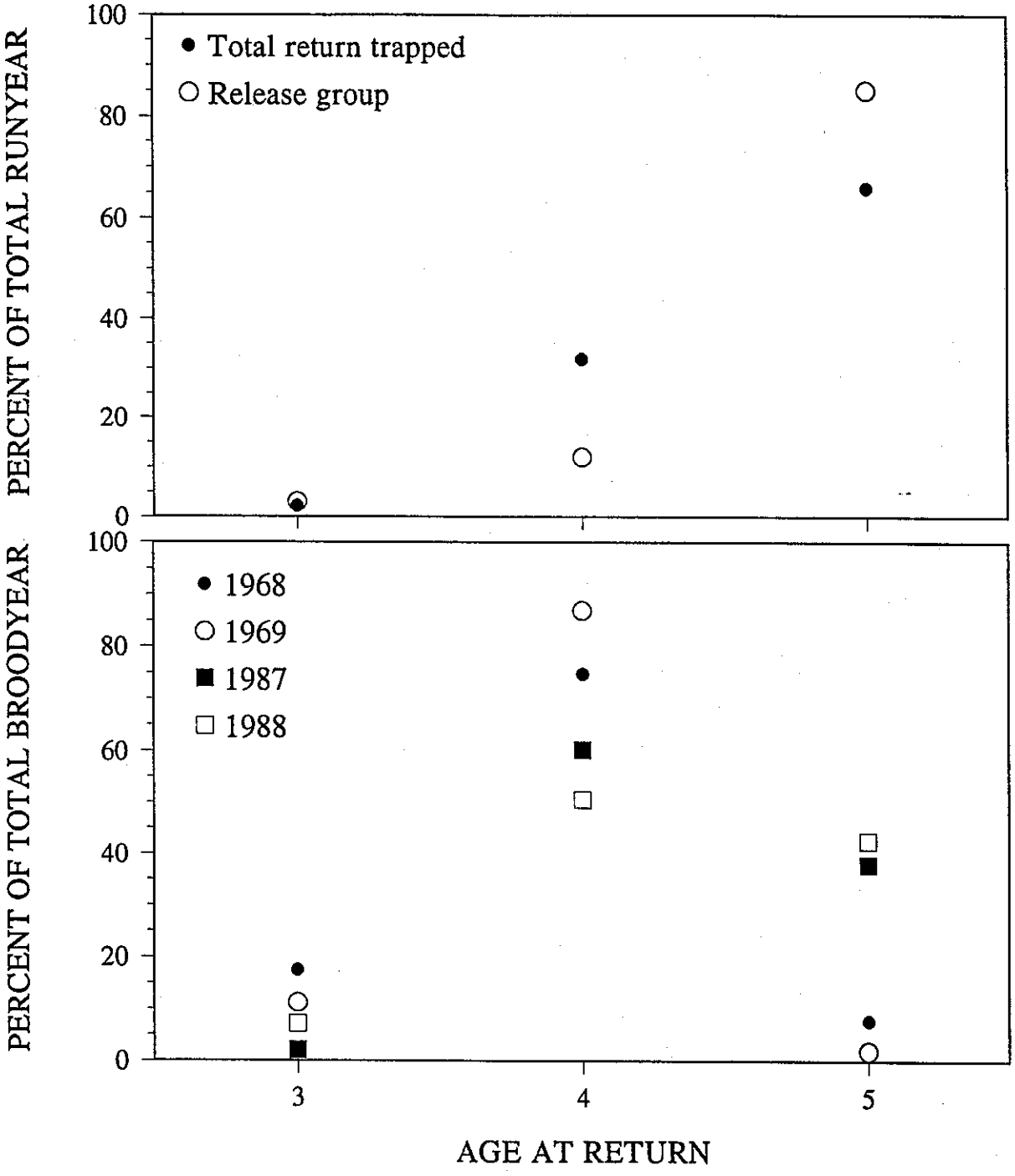

Figure 9. Age compositions for the total return and the release group for 1993 and age compositions of the 1968 and 1969 cohorts of the Lookingglass Creek stock (circles) and the 1987 and 1988 cohorts of the Rapid River stock (squares) that returned to weirs on Lookingglass Creek (Burck 1993; Messmer et al. 1992, 1994, in press).

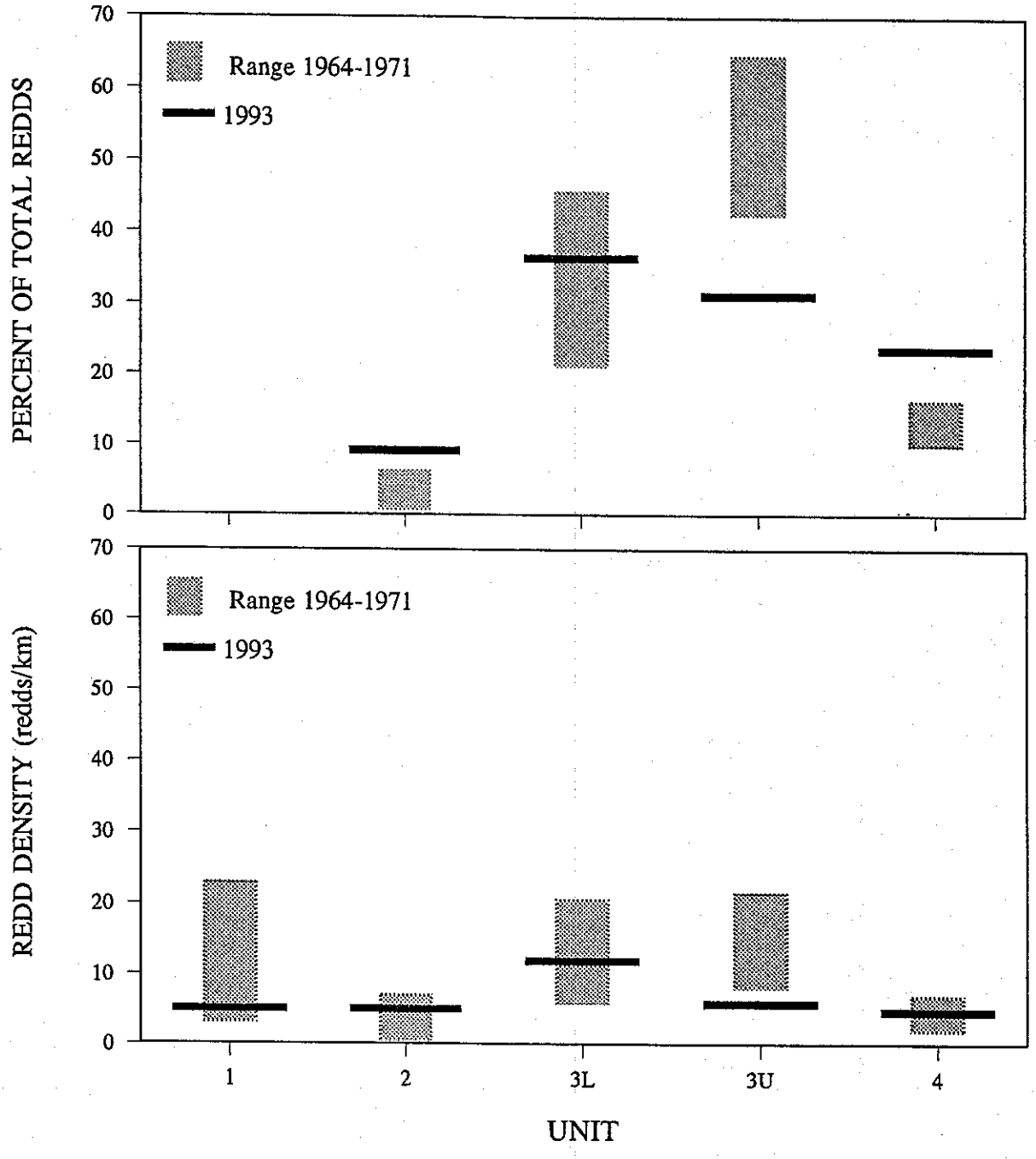

Figure 10. Percentages in units 2 to 4 of the total redds above the weir and redd densities by unit in Lookingglass Creek for 1964-1971 (Burck 1993) and 1993.

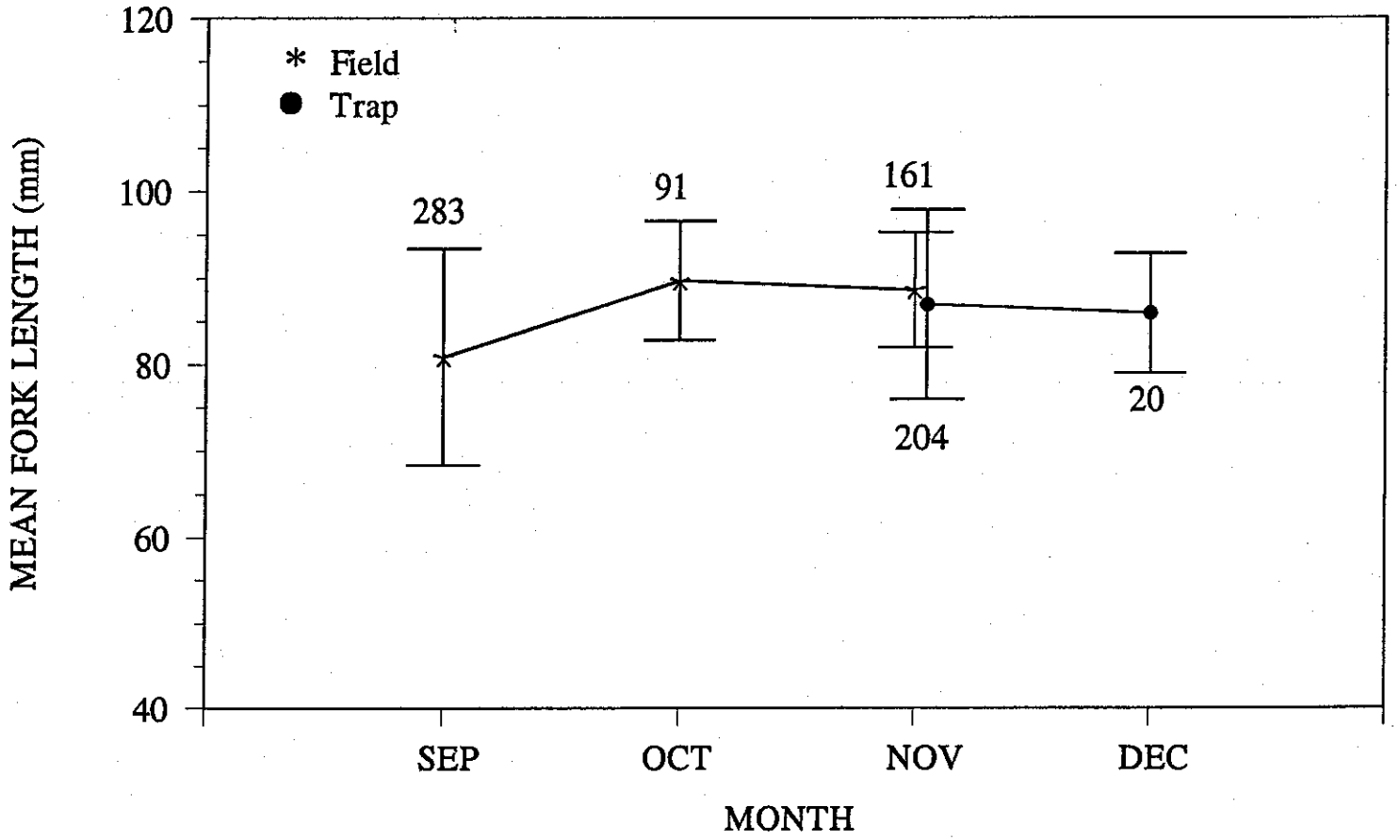

Figure 11. Mean fork length (±SD) of juvenile chinook salmon captured in Lookingglass Creek from September to December, 1993. Monthly samples were collected in the creek around the 20th of each month (field). Fish from the rotary screw trap were captured from the 15th to the 25th of each month (trap). Numbers above or below each point indicate the sample size.

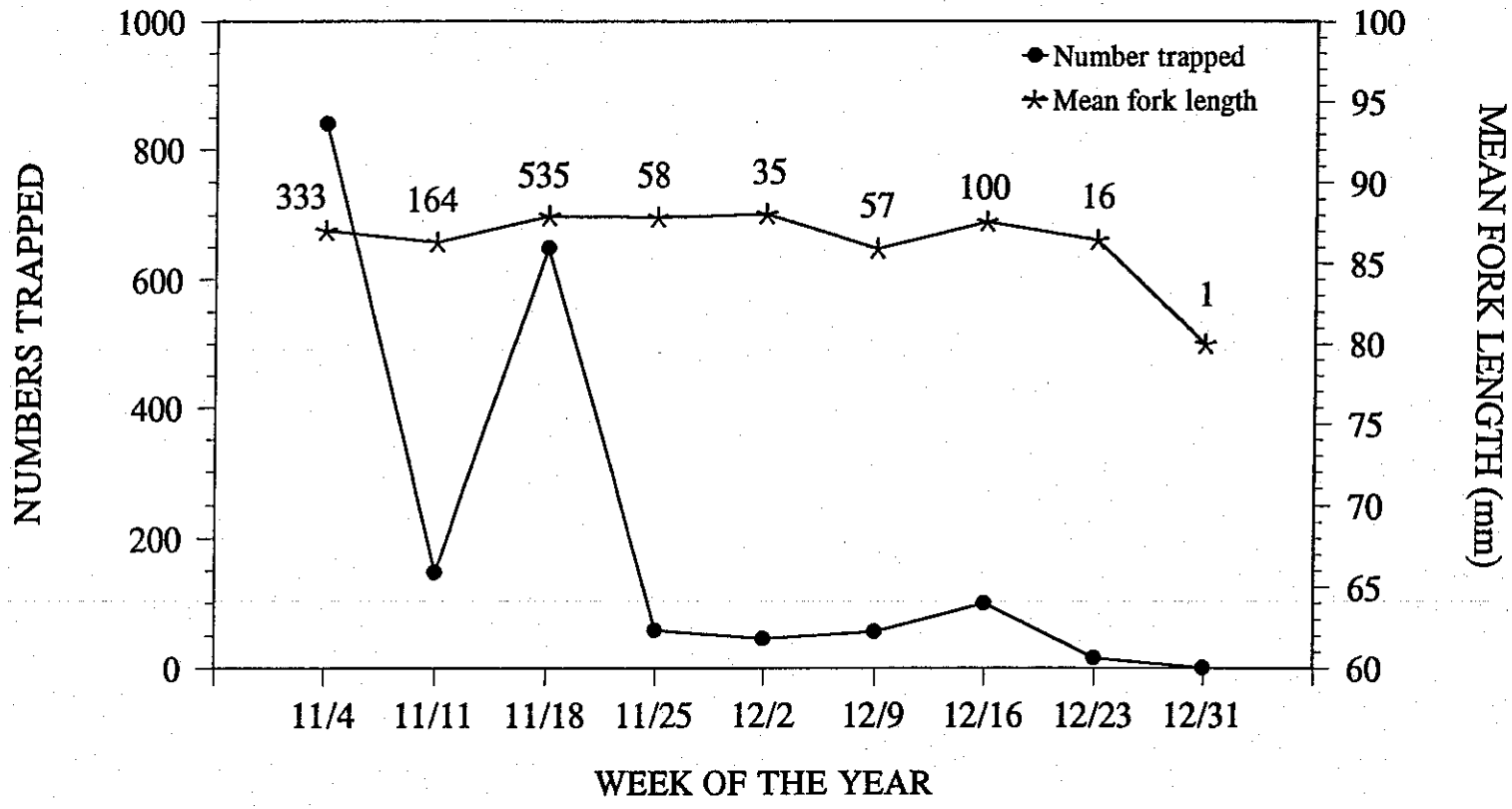

Figure 12. Numbers of juvenile chinook salmon captured in the rotary screw trap in Lookingglass Creek and mean fork lengths of fish that were measured during each period. Numbers above each point are sample sizes. The weekly periods end on the dates shown.

Discussion

The flow pattern in Lookingglass Creek in 1993 was within the ranges that have been observed in the past. The flow pattern was most like that of 1967 (Appendix Figure A-1). Peak flows were higher and more pronounced in 1993 than in 1967.

Peak water temperatures recorded in Lookingglass Creek at rkm 12.07 in 1993 were lower than those that were recorded from 1964-1971 at about rkm 6.84 (Burck 1993). Maximum stream temperatures usually reached peaks around mid-July from 1964-1971, although temperatures sometimes peaked as early as late June (e.g., 1968) (Appendix Figures A-3 and A-4). High temperatures that fluctuated around yearly peaks in the summer were common historically. Peak temperatures in 1993 were around the same dates, but were consistently at least 3 to 4°C lower than those from 1964-1971 (Appendix Figures A-3 and A-4). Peak temperatures in 1992 (Lofy and M°Lean 1995) were also lower than those observed from 1964-1971 (Burck 1993). The differences in temperature may have been due to differences in sampling sites during the two time periods. Additional data we plan to collect in the future will help determine if the sampling location may have influenced temperatures. In 1995, we are planning to install an electronic thermograph at about the same site as that where temperature data were taken during 1964-1971 (Burck 1993).

Higher prespawning mortality for Rapid River stock compared to the Lookingglass Creek stock may mean that efforts to use artificially-reared progeny of this hatchery stock for natural production may confront some impediments that the Lookingglass Creek stock did not encounter. Potential problems with mortality were suggested with relatively high prespawning mortality indices for Rapid River females above the weir in 1992 and 1993. The index for 1993 was lower than that for females above the weir in 1992 (2/23, 8.7%) but higher than the 0.0 to 4.7% range observed for the Lookingglass Creek stock (Burck 1993). A lower prespawning mortality index for untagged females in 1993 may indicate that tagging increased mortality or that fish that migrated past the weir site were in better condition than fish captured later in the hatchery trap. Results of sampling for pathogens of adult chinook salmon that were recovered from Lookingglass Creek suggested that many of the fish which were sampled in 1993 may have succumbed to bacterial kidney disease. Clinical levels of *R. salmoninarum* were found in 8 of the 14 fish that were sampled in 1993. However, a higher prespawning mortality index in 1992 was not associated with a higher incidence of individuals with clinical levels of *R. salmoninarum* (1 in 7 specimens). In 1992, 6 of the 7 prespawning mortalities had infection levels that were classified as negative or very low (Lofy and McLean 1995). No adults above the weir were injected with antibiotic (erythromycin) to reduce the severity of bacterial kidney disease in either 1992 or 1993. In 1993, *Y. ruckeri* may have contributed to poor condition of the fish that resulted in prespawning mortality, as 4 of 14 adults that were sampled had the bacteria. Sampling for *Y. ruckeri* was done on only one fish in 1992. This fish had a *Y. ruckeri* infection. No disease data were available for the Lookingglass Creek stock, but lower prespawning indices probably indicate that mortality after adults entered Lookingglass Creek was not a problem.

Our desire to release unmarked fish may have been responsible for the higher proportion of five-year-old compared to four-year-old fish in the release group compared to the total return in 1993. The 1988 Rapid River cohort was 72% unmarked fish at release, whereas the 1989 cohort was 48% unmarked (Messmer et al. 1991, 1992). Similar percentages were observed in the proportions of unmarked to marked fish at return in 1993 (Rhine Messmer, ODFW, personal communication).

We have no indications that the larger percentages of each cohort that were five-year-olds for the Rapid River stock was an artifact of out-of-basin influences. Coded-wire-tag data for the harvest of the 1991 through 1993 return years of the Rapid River stock that originated from Lookingglass Hatchery did not suggest that the four-year-olds were harvested at a higher rate than five-year-olds (Rhine Messmer, ODFW, personal communication). No harvest data were available for the Lookingglass Creek stock. Environmental conditions, fish condition (e.g., size at release for hatchery fish, size at migration for natural fish), and genetic differences between stocks (Waples et al. 1993) may have accounted for the differences that we observed.

If a larger proportion of each cohort of Rapid River stock consistently returns as older fish, larger average size may influence the success of natural production of this stock in Lookingglass Creek. Our data suggested that the larger females we sampled had a greater number of eggs. If this is the case, Rapid River females may produce more eggs per female than Lookingglass Creek females. However, if our prespawning mortality indices are indicative of actual losses of the two stocks, increased fecundity of the Rapid River stock may be offset by higher prespawning mortality. Although our data indicated a relatively large proportion of five-year-old adults that returned, this proportion was larger than the proportions observed for cohorts 1966-1978 of Rapid River stock that have returned to Rapid River Hatchery. The mean at Rapid River Hatchery was about 19% for five-year-olds (Howell et al. 1985). This lower proportion may indicate an environmental, rather than a genetic basis for the large proportions we observed. Data from future years for the Rapid River stock will indicate whether these large proportions of five-year-olds are consistent for returns to Lookingglass Creek.

The Rapid River stock adults may be distributing their redds in a somewhat different pattern than did the Lookingglass Creek stock. This was suggested by both the much higher percentage of redds observed immediately above the hatchery intake in unit 2 in both 1992 (Lofy and M'Lean 1995) and again in 1993, compared to the range observed from 1964-1971, and the higher percentages of redds above the weir in the three units closest to the hatchery compared to 1964-1971. At least two potential causes are plausible. Incomplete recovery from anesthetization of the fish in 1993 may have caused some of the fish to drift downstream after release, resulting in higher redd distributions in lower areas than those which occurred in Burck (1993). Homing of the release group to the water originating around Lookingglass Hatchery may have inhibited migration of adults further upstream of the release site, thereby increasing the number of redds in areas closest to the hatchery. If homing is causing Rapid River stock adults to spawn nearer to the hatchery, we would expect that as natural production increases, and spawning occurs in

upper areas more frequently, adults of natural origin may be more likely to spawn higher in Lookingglass Creek basins.

Because we had an estimated population size that was within the range that was observed from 1964-1971 (Burck 1993), redd densities within the previously observed ranges (except in the upper sections of unit 3) were not surprising. Redd density in unit 1 was at the low end of the range observed from 1964-1974, which probably indicates that the numbers of hatchery and natural fish that stayed below the hatchery may have been lower in 1993 than in most years from 1964-1974. A count of 132 redds that were observed above the weir was on the low end of the range (121 to 354) of that which was observed from 1964-1974 (Burck 1993). The large redd count this year may provide us next year with the largest number of juveniles that will be available for comparison to the historic database. The large numbers of adults above the weir which we observed in 1993 are not planned for any year in Lookingglass Creek in the foreseeable future.

The relationship developed to predict fecundity using fork length in 1993 explained a greater part of the variability of the data compared to the relationship developed for females spawned in 1992 ($r^2 = 0.34$, Lofy and McLean 1995). Better fit may be attributed to the greater availability of larger females (51.5% of the fish used for the equation) due to a larger proportion of older females that were spawned in 1993 (Messmer et al. in press).

Spawning timing of Rapid River stock in 1993 appeared to have been similar to that observed for the Lookingglass Creek stock from 1966-1970. Observations of live and dead fish and appearance of new redds appeared to have been closer to a normal curve in 1993 compared to 1992 (Lofy and M°Lean 1995). Similar to patterns of the Lookingglass Creek stock, the number of observations of live fish peaked about 7 to 14 days after the number of new redds and about 10 to 15 days before the peak in recoveries of carcasses. Arrival timing was apparently not correlated with spawning timing in the areas above the weir in 1993, as evidenced by the similar timing of observations of tagged and untagged adults on redds.

We were not able to PIT-tag fish captured at the trap as early as we had wished because the trap was not put into operation until late October. Interrogation at the mainstem dams of PIT-tagged juveniles from the trap and the creek which migrated out as smolts were made in 1994. We will report migration timing and survival indices from 1994 interrogations in our next annual report.

Fish/redd ratios seemed to indicate that, thus far, Rapid River stock spring chinook salmon seem to be producing redds in proportions similar to that which might be expected. At least some of the adults placed above the weir were successful in pairing, spawning, and fertilizing eggs. Eggs deposited in the 49 redds that were counted above the weir in 1992 appeared to have been viable, as suggested by outmigration of juveniles captured in the screw trap after 28 October, 1993 and the large number of juveniles available for PIT-tagging in Lookingglass Creek above the weir in the fall. It remains to be seen whether these juveniles will successfully complete their life cycle and return to Lookingglass Creek.

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SECTION II

TRIBAL HARVEST OF SPRING CHINOOK SALMON IN LOOKINGGLASS CREEK, OREGON

In 1993 the projected number of spring chinook salmon expected to return to Lookingglass Creek exceeded the number required for hatchery broodstock and for natural production above the weir. Thus, the CTUIR, the Nez Perce Tribe and the ODFW agreed to open a tribal fishery in Lookingglass Creek. Tribal personnel, including CTUIR, LSRCP project personnel, monitored the fishery. Snouts from coded-wire-tagged fish, data and scales were provided to ODFW by CTUIR personnel.

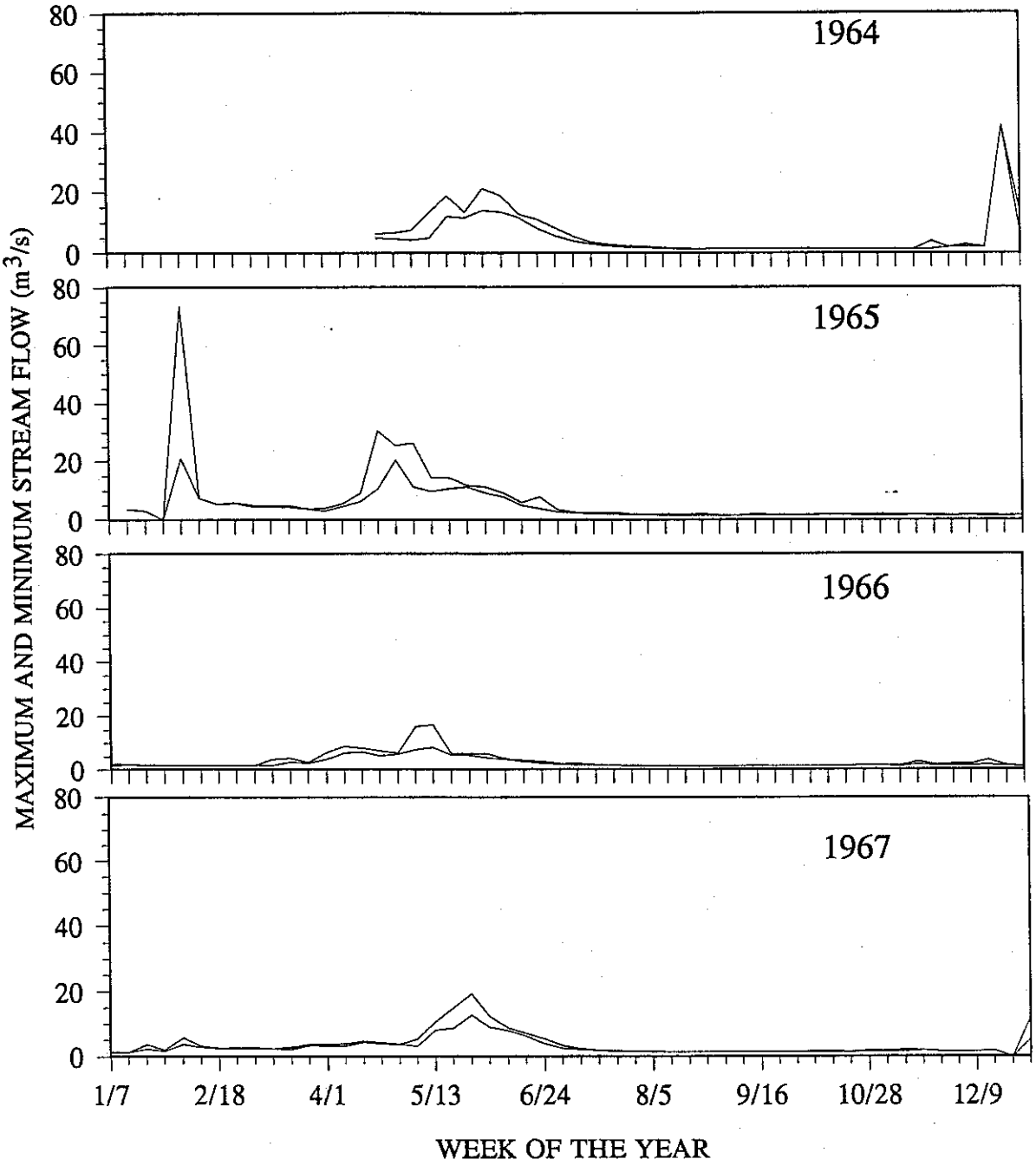
The tribal fishery was opened from the Lookingglass Hatchery intake to the mouth of Lookingglass Creek each Friday through Sunday for the period 18 June through 11 July, 1993. Personnel interviewed CTUIR tribal fishers. We estimated that 60 fish had been caught by members of the CTUIR. Tribal fishers were very cooperative in allowing us to check fish. We collected data on all 57 of the fish that we observed. Three fish were reported caught without having been sampled. Two fish that had been disc-tagged were caught by tribal fishers. All data were provided to ODFW for inclusion among information on spring chinook salmon returning to Lookingglass Creek. The Nez Perce Tribe estimated catch of their fishers as 50 fish (personal communication, James Mony, Nez Perce Tribe).

SECTION III

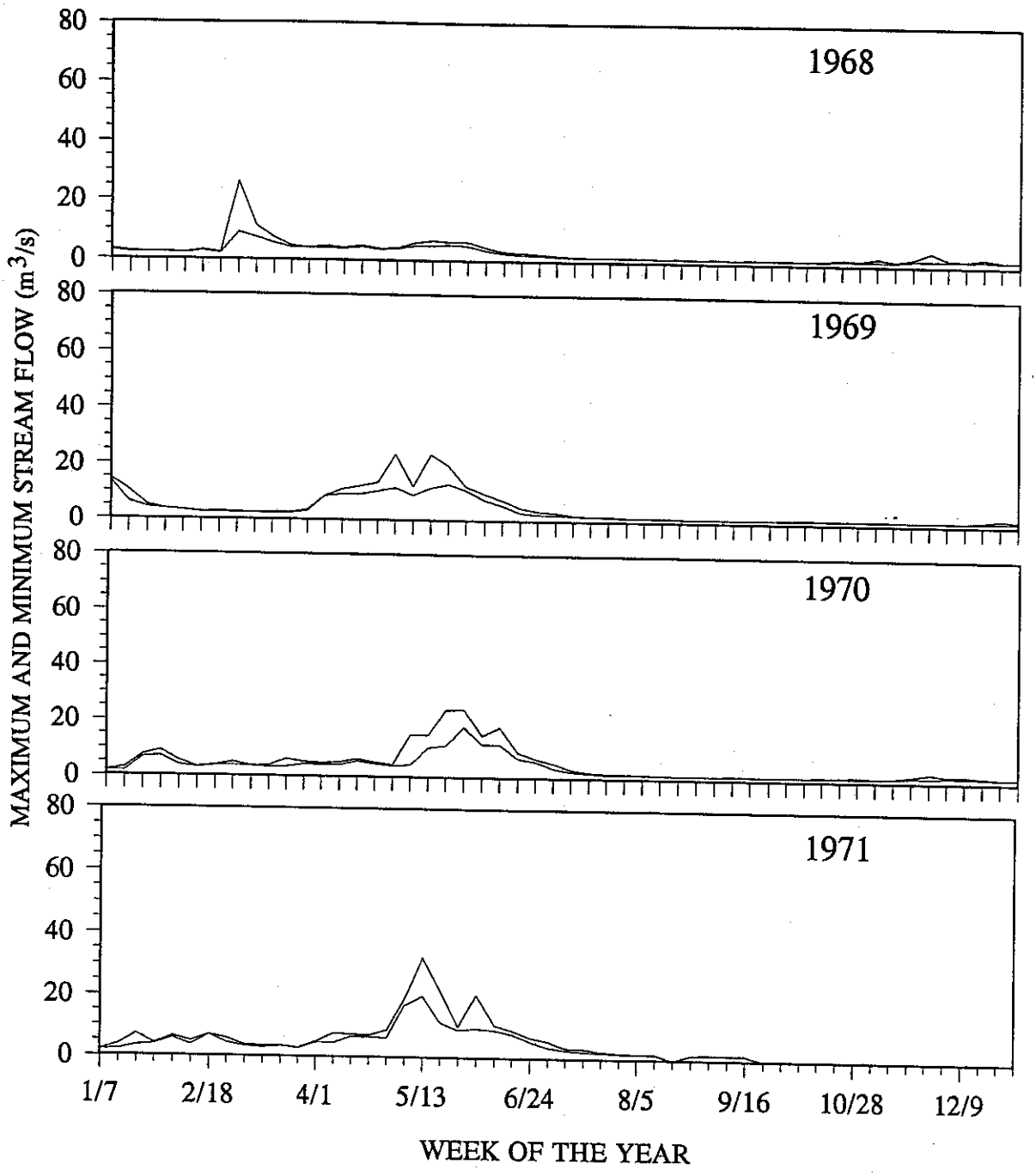
ASSISTANCE PROVIDED TO LSRCP COOPERATORS

We provided assistance to ODFW in 1993 for ongoing hatchery evaluation research. Project personnel completed extensive spawning ground surveys for spring chinook salmon in the Grande Ronde and Imnaha river basins. We provided assistance in pre-release sampling of juvenile summer steelhead at Irrigon Hatchery and the Little Sheep and Big Canyon acclimation facilities and spring chinook salmon at Lookingglass Hatchery and the Imnaha River Facility. In addition, project personnel provided assistance in sampling adult spring chinook salmon and summer steelhead at Oregon LSRCP facilities. Assistance was provided in data summarization and analysis for ODFW monthly and annual progress reports. Data used in scale pattern analysis to differentiate the scales of hatchery from naturally-produced spring chinook salmon which were collected on spawning grounds were summarized and provided to the ODFW scale reading laboratory in Corvallis. Details of data collection, summarization and analysis are not included in this report and are available in ODFW reports.

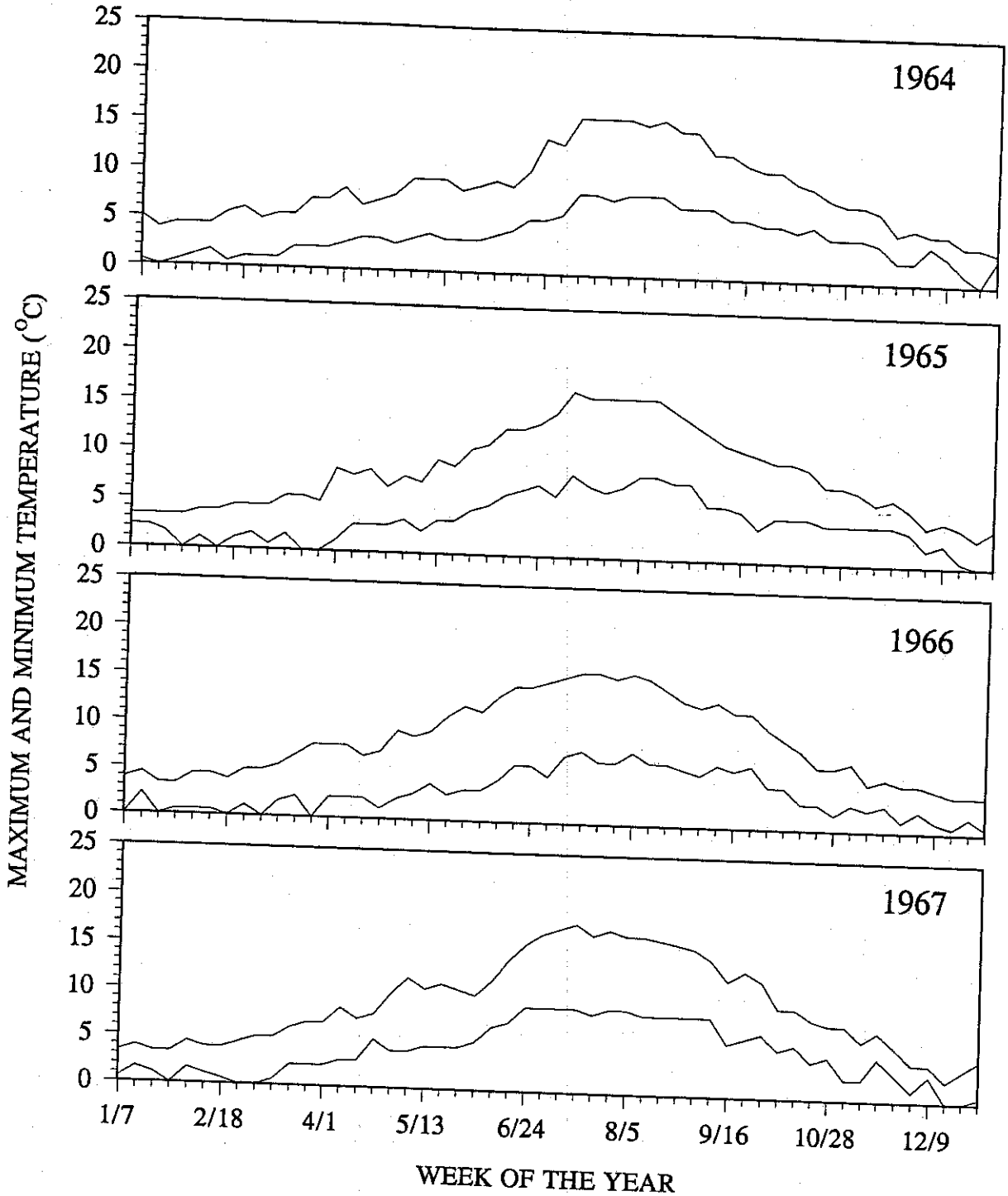
Appendices



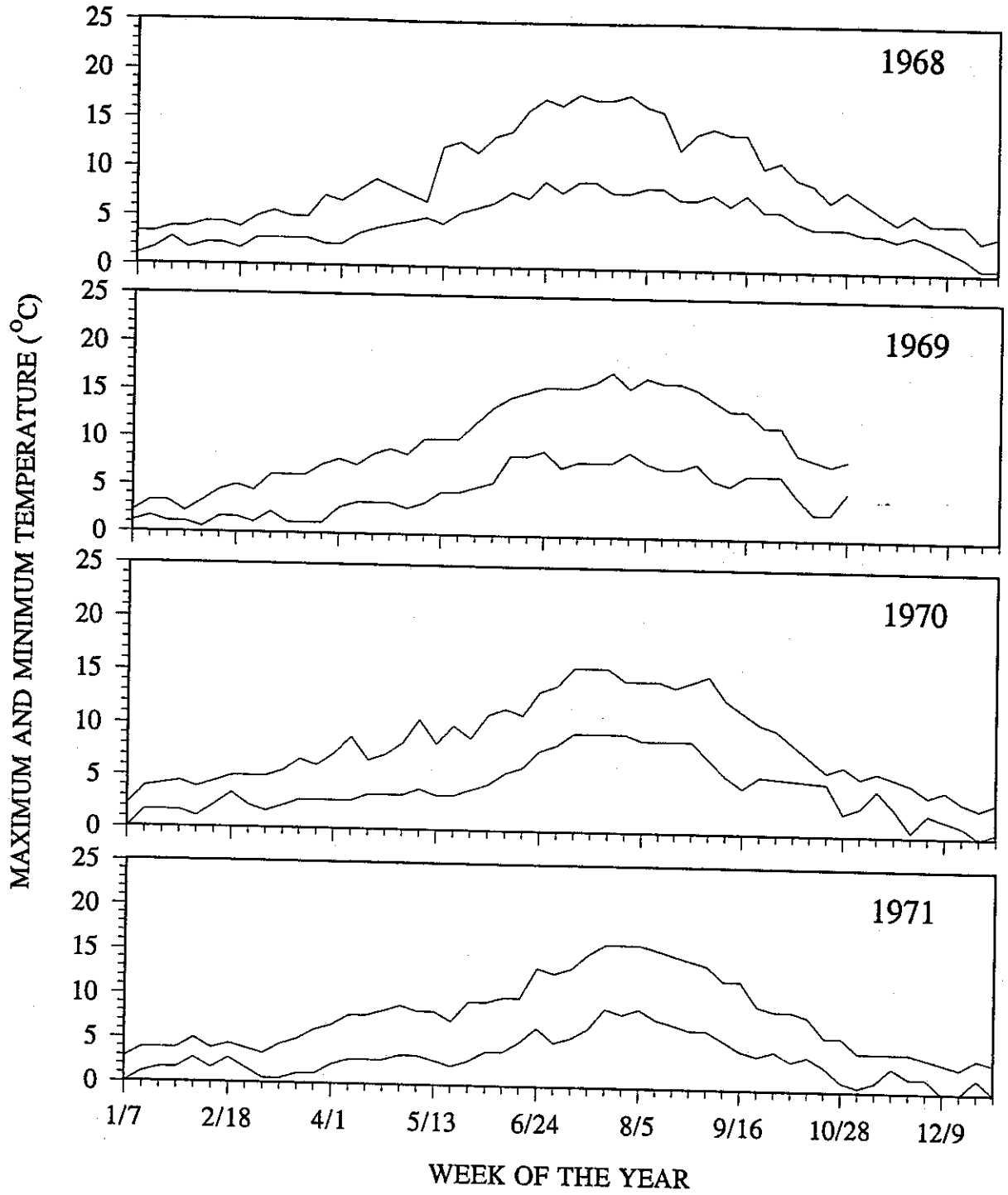
Appendix Figure A-1. Range of weekly stream flows for Lookingglass Creek from 1964-1967 (Burck 1993). The ranges of flows are week of the year maximums and minimums of single daily flows measured by methods reported in Burck (1993). The weekly periods end on the date shown.



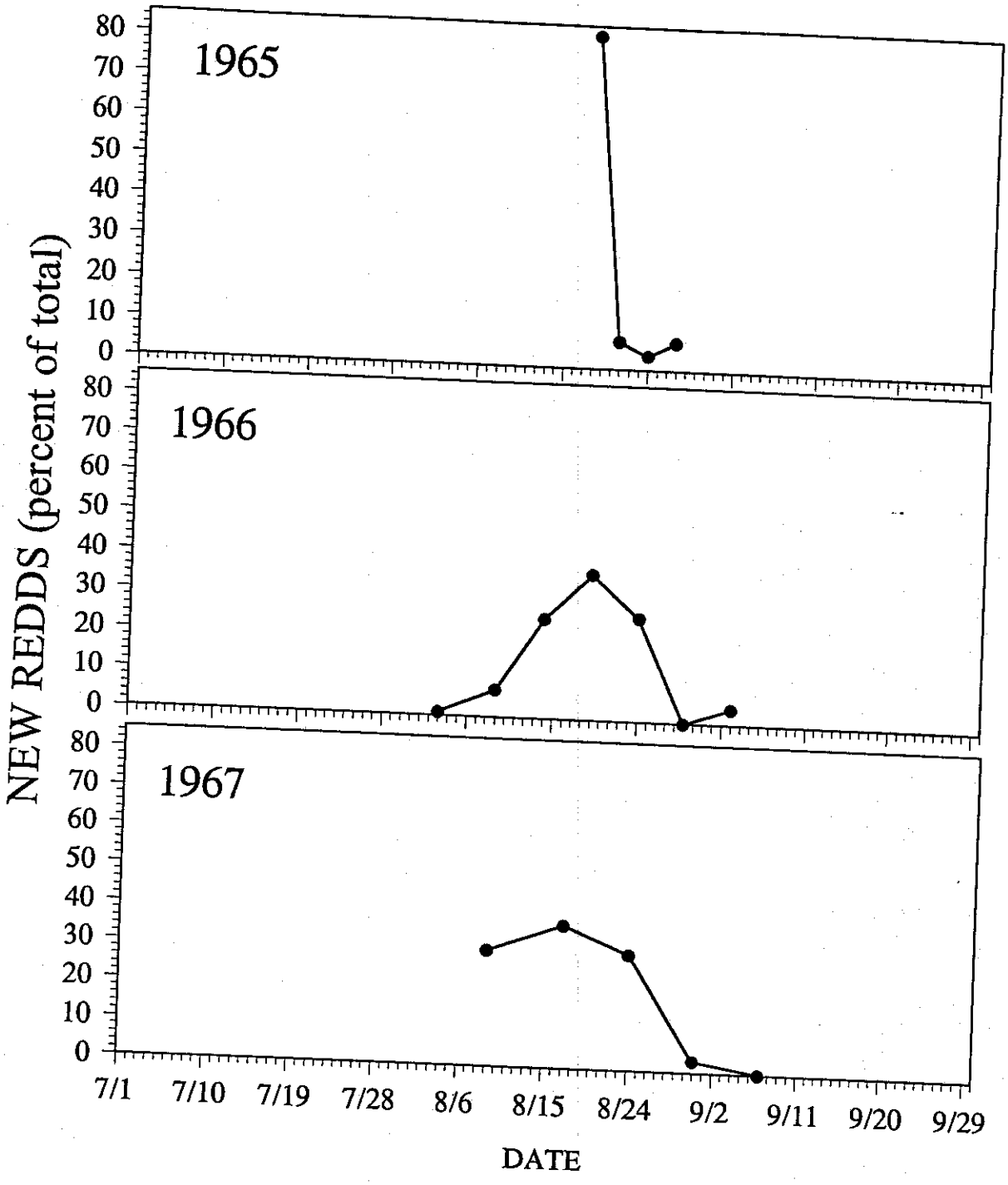
Appendix Figure A-2. Range of weekly stream flows for Lookingglass Creek from 1968-1971 (Burck 1993). The ranges of flows are week of the year maximums and minimums of single daily flows measured by methods reported in Burck (1993). The weekly periods end on the date shown.



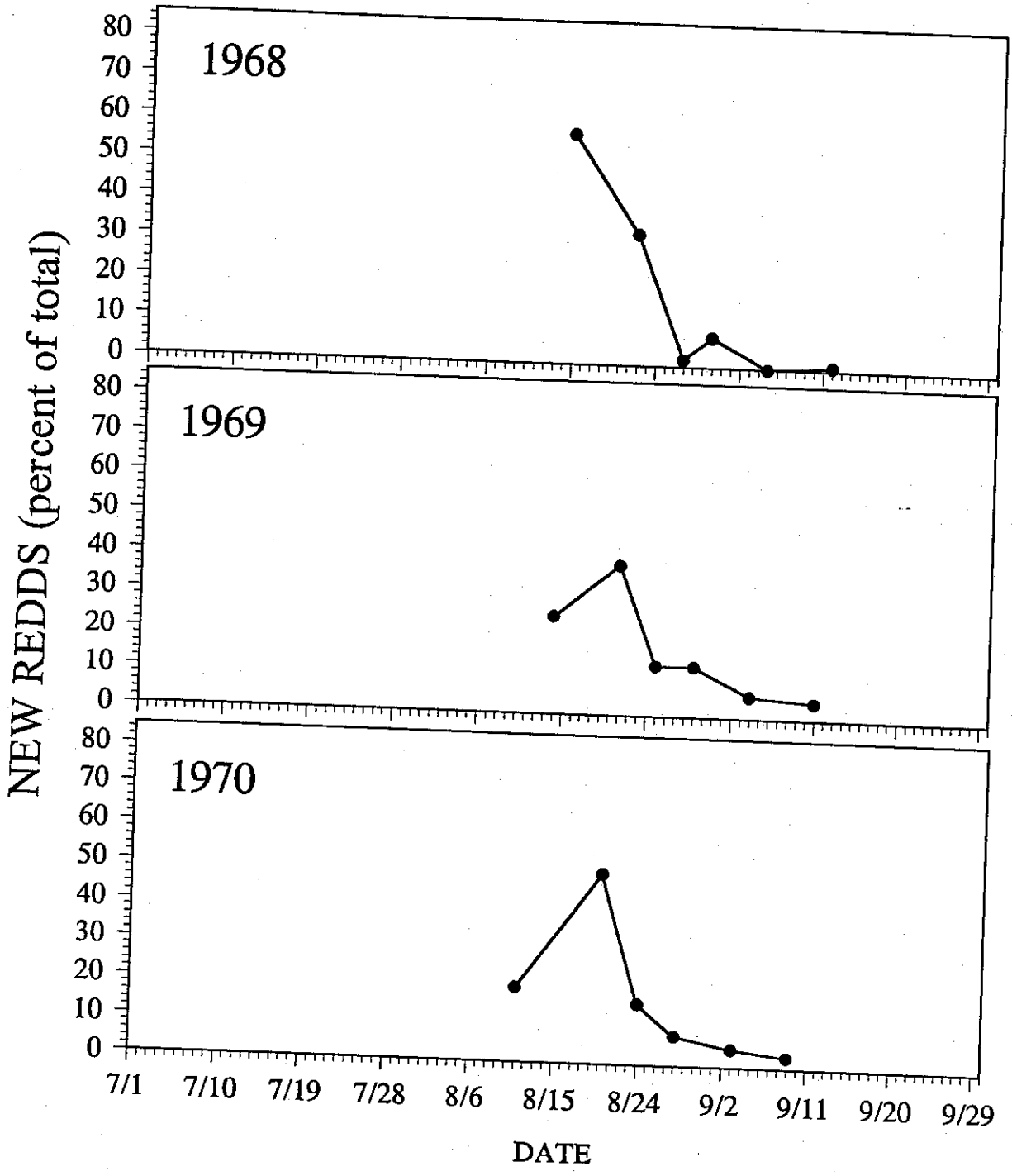
Appendix Figure A-3. Range of weekly stream temperatures for Lookingglass Creek from 1964-1967 (Burck 1993). All of the temperature data are weekly ranges summarized from Burck (1993). The weekly periods end on the date shown.



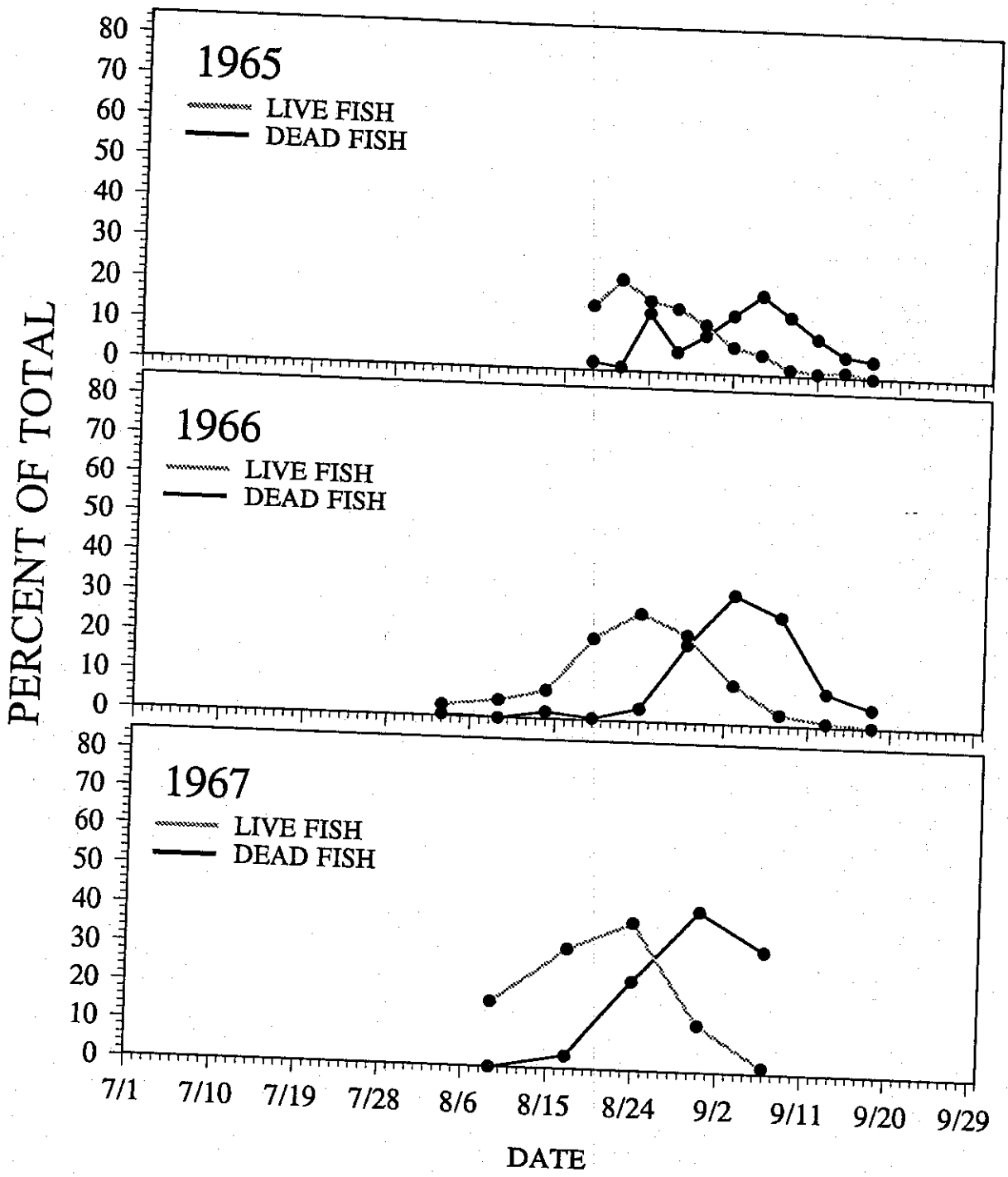
Appendix Figure A-4. Range of weekly stream temperatures for Lookingglass Creek from 1968-1971 (Burck 1993). All of the temperature data are weekly ranges summarized from Burck (1993). The weekly periods end on the date shown.



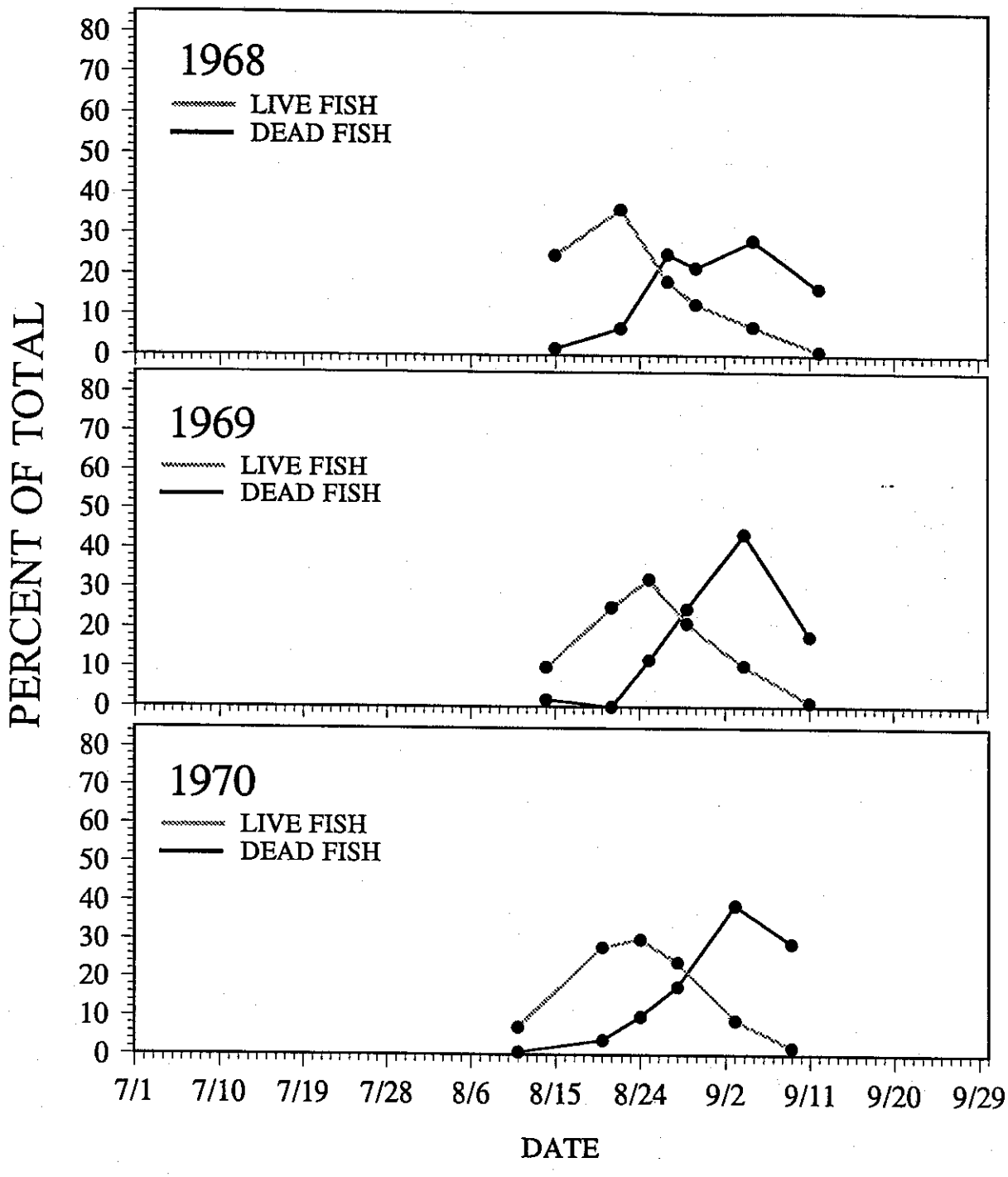
Appendix Figure A-5. Percent of new redds seen during a spawning survey of the total new redds observed in the unit 3 in Lookingglass Creek from 1965-1967 (Burck 1964-1974).



Appendix Figure A-6. Percent of new redds seen during a spawning survey of the total new redds observed in the unit 3 in Lookingglass Creek from 1968-1970 (Burck 1964-1974).



Appendix Figure A-7. Percent of live and dead fish seen during a spawning survey of the total number of fish observed in unit 3 in Lookingglass Creek from 1965-1967 (Burck 1964-1974).



Appendix Figure A-8. Percent of live and dead fish seen during a spawning survey of the total number of fish observed in unit 3 in Lookingglass Creek from 1968-1970 (Burck 1964-1974).

Appendix Table B-1. Spawning ground survey data collected in 1993.

Start location
End location
Date of survey
Surveyor initials
Start time, temperature, weather
End time, temperature, weather

Live fish (on or off redd)
Redd date, is the date recorded on the flag
Redd number.

Fork Length (mm)
Sex (Male, Female, or Unknown)
Fin Mark (ad, lv, rv, or any combination seen on the fish).
Operculum Punch/Tag Number (number of holes in the operculum, and which side of the operculum was punched: ROP, right; LOP, left).
Snout ID (the 7 digit code used for identifying the snout)
Other comments

Appendix Table B-2. Adult spring chinook salmon disc-tagged and released above the weir in Lookingglass Creek in 1993.

Date tagged	Fork length (mm)	Assigned sex[a]	Mark[b]	Disc tag number[c]	Age	Cohort Year
06/14	870	M		1	5	88
06/14	760	F		2	5	88
06/14	950	M		3	5	88
06/14	735	F		4	5	88
06/14	810	F		5	5	88
06/14	823	F		6	5	88
06/14	830	F		7	5	88
06/14	859	M		8	5	88
06/14	840	M		9	5	88
06/14	820	F		10	5	88
06/14	775	F		11	5	88
06/14	860	F		12	5	88
06/14	910	M		13	5	88
06/14	715	M		14	5	88
06/14	895	M		15	5	88
06/14	929	M		16	5	88
06/14	960	M		17	5	88
06/17	850	F		18	5	88
06/17	825	F		19	5	88
06/17	870	F		20	5	88
06/17	445	M	RV	21	3	90
06/17	860	M		22	5	88
06/17	890	F		23	5	88
06/17	885	F		24	5	88
06/17	850	M		25	5	88
06/17	840	F		26	5	88
06/17	900	M		27	5	88
06/17	870	F		28	5	88
06/17	780	M		29	4	89
06/17	870	F		30	5	88
06/17	820	F		31	5	88
06/17	860	F		32	5	88
06/17	930	M		33	5	88
06/17	815	M		34	5	88

Appendix Table B-2 (cont.). Adult spring chinook salmon disc-tagged and released above the weir in Lookingglass Creek in 1993 (cont.).

Date tagged	Fork length (mm)	Assigned sex[a]	Mark[b]	Disc tag number[c]	Age	Cohort Year
06/17	720	M		35	4	89
06/17	660	M		36	4	89
06/17	860	F		37	5	88
06/17	890	M		38	5	88
06/17	920	M		39	5	88
06/17	838	M		40	4	89
06/23	865	M		41	5	88
06/23	875	F		42	5	88
06/23	745	F		43	4	89
06/23	865	F		44	5	88
06/23	900	M		45	5	88
06/23	855	F		46	5	88
06/23	965	M		47	5	88
06/23	755	F		48	4	89
06/23	895	M		49	5	88
06/23	870	M		50	5	88
06/23	730	F		51	4	89
06/23	875	F		52	5	88
06/23	810	M		53	5	88
06/23	930	M		54	5	88
06/23	850	F		55	5	88
06/23	865	M		56	5	88
06/23	790	F		57	5	88
06/23	840	F		58	5	88
06/23	925	M		VIT50	5	88
06/30	740	F		59	5	88
06/30	880	M		60	5	88
06/30	730	F		61	5	88
06/30	810	M		62	4	89
06/30	900	M		63	5	88
06/30	950	M		64	5	88
06/30	490	M		65	3	90
06/30	490	M		66	3	90
06/30	870	F		67	5	88

Appendix Table B-2 (cont.). Adult spring chinook salmon disc-tagged and released above the weir on Lookingglass Creek in 1993 (cont.).

Date tagged	Fork length (mm)	Assigned sex[a]	Mark[b]	Disc tag number[c]	Age	Cohort Year
06/30	820	F		68	5	88
06/30	830	M		69	5	88
06/30	880	F		70	5	88
06/30	780	M		71	5	88
06/30	960	M		72	5	88
06/30	775	F		73	5	88
06/30	840	F		74	5	88
06/30	915	M		75	5	88
06/30	840	F		76	5	88
06/30	800	F		77	5	88
06/30	880	M		78	5	88
06/30	850	F		79	5	88
06/30	660	M		80	4	89
07/06	930	M		81	5	88
07/06	780	F		82	4	89
07/06	710	F		83	5	88
07/06	810	M		84	4	89
07/06	820	F		85	5	88
07/06	830	F		86	5	88
07/06	680	F		87	4	89
07/14	800	M		88	5	88
07/14	930	M		89	5	88
07/14	885	F		90	5	88
07/14	870	F	AD	91	5	88
08/02	860	M		92	5	88
08/02	815	F		93	5	88
08/02	890	F		94	5	88
08/12	850	F		95	5	88
08/12	945	M		96	5	88
08/12	835	F		97	5	88
08/18	970	M		98	5	88

a The sex of the fish was assigned at the time of tagging.
b AD = adipose-fin-clipped, RV = right ventral-fin-clipped.
c VIT = visible implant tag previously applied at a downstream dam.

Appendix Table B-3. Adult spring chinook salmon recovered on Lookingglass and Little Lookingglass creeks in 1993.

Date recovered	Date tagged	Fork length (mm)	Sex	Mark[a]	CWT[b]	Disc tag no.[c]	Age	Cohort year	Recovery unit[d]
07/02	06/23	855	F			46	5	88	1
07/04	06/14	775	F			11	4	88	1
08/06	06/23	810	M			53	5	88	1
09/10	06/30	490	M			65	3	90	1
10/07	06/23	745	F			43	4	88	1
09/03		440	M			TL			1
08/03	06/23	865	F			44	5	88	2
08/25	06/17	860	M			22	5	88	2
09/02	06/23	755	F			48	4	88	2
09/09	06/14	810	F			5	5	88	2
09/09	06/30	925	M			VIT	5	88	2
09/09	06/30	820	F			68	5	88	2
09/02		UNK	F			TL			2
09/02		UNK	F			TL			2
09/09		UNK	F			TL			2
08/19	06/14	760	F			2	4	88	W
09/09	06/30	840	F			74	5	88	W
UNK	06/17	900	M			27	5	88	W
UNK		UNK	M			TL			W
08/10	06/30	960	M			72	5	88	3L
08/18	07/06	930	M			81	5	88	3L
08/25	06/23	900	M			45	5	88	3L
09/02	07/14	930	M			89	5	88	3L
09/02	06/30	915	M			75	5	88	3L
09/02	06/30	850	F			79	5	88	3L
09/02	08/02	815	F			93	5	88	3L
09/02	08/12	890	F			94	5	88	3L
09/02	06/30	800	F			77	5	88	3L
09/09	06/23	840	F			58	5	88	3L
09/09	06/17	885	F			24	5	88	3L
08/18		965	M			TL			3L
09/02		UNK	F			TL			3L
09/02		UNK	F			TL			3L

Appendix Table B-3. Adult spring chinook salmon recovered on Lookingglass and Little Lookingglass creeks in 1993 (cont.).

Date recovered	Date tagged	Fork length (mm)	Sex	Mark[a]	CWT[b]	Disc tag no.[c]	Age	Cohort year	Recovery unit[d]
09/02	UNK		M			TL			3L
09/02	UNK		M			TL			3L
09/09	UNK					TL			3L
09/21	UNK		M			TL			3L
09/24	UNK		M			TL			3L
09/02	08/18	835	F			97	5	89	3U
08/10	06/30	880	F			70	5	89	3U
08/25	06/17	870	F			30	5	88	3U
08/25		835	F			TL			3U
08/25		865	M			TL			3U
09/02		UNK	M			TL			3U
09/02		UNK	F			TL			3U
08/26	08/12	945	M			96	5	88	4
08/26	06/30	830	F			69	5	88	4
08/26	08/02	870	F	AD	074743	91	5	88	4
09/03	06/14	820	F			10	5	88	4
09/10	06/30	740	F			59	4	88	4
08/06		780	F	LV		NT	4	89	1
08/06		800	F	LV		NT	4	89	1
08/11		800	F			NT	5	88	1
08/20		830	F	AD	074739	NT	5	88	1
08/20		730	F	LV		NT	4	89	1
08/26		UNK	M			NT			1
08/26		850	M	LV		NT	5	88	1
08/26		715	M			NT	4	89	1
08/26		860	F			NT	5	88	1
09/03		750	F	ADLV	N	NT	4	89	1
09/03		810	F			NT	5	88	1
09/03		830	F			NT	5	88	1
09/03		720	M			NT	5	88	1
09/03		840	F			NT	5	88	1
09/03		500	M	RV		NT	3	90	1

Appendix Table B-3. Adult spring chinook salmon recovered on Lookingglass and Little Lookingglass creeks in 1993 (cont.).

Date recovered	Date tagged	Fork length (mm)	Sex	Mark[a]	CWT[b]	Disc tag no.[c]	Age	Cohort year	Recovery unit[d]
09/03		760	M			NT	4	89	1
09/03		820	F			NT	5	88	1
09/03		870	F			NT	5	88	1
09/03		800	F	AD	074739	NT	5	88	1
09/09		865	F			NT	5	88	1
09/10		660	F	AD	075051	NT	4	89	1
09/30		910	M			NT	5	88	1
10/07		790	F			NT			1
08/18		800	M	LV		NT	4	89	2
08/18		835	F	AD	074749	NT	5	88	2
08/18		905	M			NT	5	88	2
08/18		970	M			NT	5	88	2
08/25		790	M			NT	4	89	2
08/25		790	M			NT	5	88	2
08/25		910	M			NT	5	88	2
08/25		770	M			NT	4	89	2
09/02		1025	M			NT	5	88	2
09/02		870	M			NT	5	88	2
09/02		610	M	AD	N	NT	3	90	2
09/02		770	M			NT	4	89	2
09/02		945	M			NT	5	88	2
09/09		710	M			NT	4	89	2
09/09		860	F			NT	5	88	2
09/09		820	F			NT	5	88	2
08/10		UNK	F			NT			3L
08/18		990	M			NT	5	88	3L
08/18		820	M			NT	5	88	3L
08/18		880	M	AD	074739	NT	5	88	3L
08/25		920	M	AD	074740	NT	5	88	3L
08/25		800	M			NT	5	88	3L
08/25		840	F			NT	5	88	3L

Appendix Table B-3. Adult spring chinook salmon recovered on Lookingglass and Little Lookingglass creeks in 1993 (cont.).

Date recovered	Date tagged	Fork length (mm)	Sex	Mark[a]	CWT[b]	Disc tag no.[c]	Age	Cohort year	Recovery unit[d]
08/25		885	F			NT	5	88	3L
08/25		930	M			NT	5	88	3L
08/25		710	F	LV		NT	4	89	3L
08/25		460	M			NT	3	90	3L
08/25		790	F			NT	5	88	3L
08/25		740	M	AD	075054	NT	4	89	3L
09/02		685	F			NT	4	89	3L
09/02		910	F			NT	5	88	3L
09/02		1050	M			NT	5	88	3L
09/02		790	F			NT	4	89	3L
09/02		910	F			NT	5	88	3L
09/02		490	M	AD	075305	NT	3	90	3L
09/02		670	F			NT	4	89	3L
09/02		745	F			NT	4	89	3L
09/02		805	F			NT	5	88	3L
09/02		915	M			NT	5	88	3L
09/02		850	M	AD	N	NT	5	88	3L
09/02		805	F			NT	5	88	3L
09/09		750	F	AD	074740	NT	5	88	3L
09/09		850	F			NT	5	88	3L
09/28		UNK	M	AD	(--)	NT			3L
08/17		730	F	LV		NT	4	89	3U
08/17		890	M			NT	5	88	3U
08/17		950	M			NT	5	88	3U
08/25		790	F	AD	N	NT	5	88	3U
08/25		830	F			NT	5	88	3U
08/25		845	F			NT	5	88	3U
08/25		800	F			NT	5	88	3U
08/25		905	M			NT	5	88	3U
08/25		805	F			NT	5	88	3U
08/25		845	F			NT	5	88	3U
08/25		805	M	AD	075054	NT	4	89	3U

Appendix Table B-3. Adult spring chinook salmon recovered on Lookingglass and Little Lookingglass creeks in 1993 (cont.).

Date recovered	Date tagged	Fork length (mm)	Sex	Mark[a]	CWT[b]	Disc tag no.[c]	Age	Cohort year	Recovery unit[d]
08/25		750	M			NT	4	89	3U
09/02		920	M			NT	5	88	3U
09/02		650	F			NT	4	89	3U
09/02		820	F			NT	5	88	3U
09/02		910	M			NT	5	88	3U
09/02		860	F			NT	5	88	3U
09/02		790	F			NT	4	89	3U
09/02		840	F			NT	5	88	3U
09/02		840	F			NT	5	88	3U
09/02		720	F			NT	4	89	3U
09/02		890	F			NT	5	88	3U
09/09		860	F			NT	5	88	3U
09/09		870	F			NT	5	88	3U
09/09		765	F			NT	5	88	3U
09/09		820	F	AD	N	NT	5	88	3U
09/09		760	F			NT	4	89	3U
09/09		710	F	AD	075051	NT	4	89	3U
08/13		840	F			NT	5	88	4
08/19		720	F	LV		NT	4	89	4
08/19		870	F	AD	074739	NT	5	88	4
08/19		795	F			NT	5	88	4
08/19		860	M	AD	074740	NT	5	88	4
08/19		880	F			NT	5	88	4
08/19		715	F			NT	4	89	4
08/19		965	M			NT	5	88	4
08/26		750	F			NT	5	88	4
08/26		850	M			NT	5	88	4
08/26		700	F	AD	075048	NT	4	89	4
08/26		750	F			NT	4	89	4
09/03		840	F			NT	5	88	4
09/03		920	F	AD	074739	NT	5	88	4
09/03		950	M			NT	5	88	4

Appendix Table B-3. Adult spring chinook salmon recovered on Lookingglass and Little Lookingglass creeks in 1993 (cont.).

Date recovered	Date tagged	Fork length (mm)	Sex	Mark[a]	CWT[b]	Disc tag no.[c]	Age	Cohort year	Recovery unit[d]
09/03		855	F			NT	5	88	4
09/03		670	F			NT	4	89	4
09/03		685	F	AD	075048	NT	4	89	4
09/03		700	F	AD	075053	NT	4	89	4
09/03		840	F			NT	5	88	4
09/03		695	F			NT	4	89	4
09/03		760	F	AD	N	NT	4	89	4
09/03		850	F	AD	074740	NT	5	88	4
09/10		800	F	AD	N	NT	5	88	4
09/10		850	F			NT	5	88	4
09/10		790	F			NT			4
09/10		780	M			NT	4	89	4
09/10		660	F			NT	4	89	4

a AD = adipose-fin-clipped (coded-wire tag). LV = pelvic fin clip (Carson Hatchery stock). NT = not disc-tagged.

b Coded-wire-tag number. N = snout did not contain a tag. (--) = snout was not collected.

c NT = the fish had no punches or disc tags.

d The unit in which the fish was recovered.
W = collected on the picket weir at the downstream end of unit 2.

Appendix Table B-4. Percent of the spring chinook salmon by week of the year that returned to Lookingglass Creek weirs from 1964-1974, 1992, and 1993.

Run Year	Group[b]	Week of the year[a] 5/6	5/13	5/20	5/27	6/3	6/10	6/17	6/24	7/1	7/8	7/15	7/22	7/29	8/5	8/12	8/19	8/26	9/2	9/9	9/16	N
1964	LG	0.0	0.0	0.0	0.0	1.4	5.6	9.9	21.1	28.2	11.3	14.1	4.2	1.4	0.0	1.4	0.0	0.0	1.4	0.0	0.0	71
1965	LG	0.0	0.0	0.0	0.0	5.3	10.5	10.5	13.2	13.2	21.1	2.6	2.6	5.3	0.0	2.6	7.9	5.3	0.0	0.0	0.0	38
1966	LG	0.0	0.0	1.1	21.2	8.3	2.3	41.0	5.2	10.6	2.0	2.0	0.3	0.0	0.3	0.6	2.6	1.7	0.9	0.0	0.0	349
1967	LG	0.0	0.0	0.0	0.0	6.1	12.3	15.2	16.4	16.4	12.7	11.1	3.3	0.8	0.8	0.4	0.8	1.6	0.8	1.2	0.0	243
1968	LG	0.0	0.0	3.4	7.5	19.4	16.0	18.1	16.8	7.0	6.2	1.8	0.8	1.3	0.3	0.3	0.0	0.8	0.3	0.3	0.0	387
1969	LG	0.0	0.0	0.0	0.5	5.7	36.8	16.7	19.5	5.7	5.1	3.3	1.8	1.1	0.0	0.3	1.2	1.7	0.6	0.0	0.0	663
1970	LG	0.0	0.0	0.0	0.0	3.4	10.5	5.4	31.5	10.0	23.2	7.3	4.4	0.8	0.6	0.3	0.8	0.8	0.3	0.6	0.1	727
1971	LG	0.0	0.0	0.0	0.0	0.0	1.2	5.9	20.6	12.0	22.8	20.1	12.5	1.0	1.0	0.5	0.0	1.0	1.2	0.2	0.0	408
1972	LG	0.0	0.0	0.0	0.0	1.4	9.7	7.2	21.7	24.9	16.2	9.7	6.1	2.5	0.4	0.0	0.0	0.0	0.0	0.0	0.0	277
1973	LG	0.0	0.0	17.2	14.2	21.9	29.9	1.1	10.2	2.2	1.5	0.7	0.7	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	273
1974	LG	0.0	0.0	0.0	0.0	0.0	0.0	1.3	25.6	11.5	15.4	25.6	12.8	6.4	1.3	0.0	0.0	0.0	0.0	0.0	0.0	78
1990	RR	0.0	0.0	0.0	31.8	28.5	12.0	7.1	5.7	4.1	1.6	0.0	1.2	0.0	0.0	0.0	1.4	1.2	4.5	0.4	0.2	519
1991	RR	0.0	0.0	0.0	0.0	0.0	1.4	22.8	20.6	23.1	11.3	3.6	2.5	0.0	0.5	2.5	0.0	8.8	1.9	0.0	1.1	362
1992	RR	0.0	18.2	4.7	40.0	20.9	4.6	3.4	3.9	0.6	0.2	0.4	0.0	0.4	0.0	0.7	1.2	0.0	0.0	0.7	0.0	912
1992	Rel[c]	0.0	0.0	0.0	25.8	26.9	21.5	15.1	0.0	3.2	0.0	1.1	0.0	2.1	0.0	1.1	3.2	0.0	0.0	0.0	0.0	93[c]
1993	RR[d]					--	48.8	8.3	25.2	6.4	1.7	1.3	--	--	2.2	1.0	1.0	2.3	0.8	0.6	0.4	1020
1993	Rel							39.4	19.2	22.2	7.1	4.0	0.0	0.0	3.0	3.0	2.0	0.0	0.0	0.0	0.0	99

a Week of the year which ended on the date shown.

b LG = Lookingglass Creek stock, summarized from Burck (1964-1974). RR = Rapid River stock retuning to Lookingglass Hathcery, summarized from Messmer (1992, 1994). Rel = Rapid River group of fish released above the weir.

c Does not include 40 fish released 10 September, 1993.

d (--) = Trap was in operation but holding pond was not checked. Trap was put into operation on 28 May in 1993.

Appendix Table B-5. Age composition of chinook salmon that returned to Lookingglass Creek 1971-1974 and 1990-1993, as well as the 1992 and 1993 release groups.

Run year	Group[a]	Age at return: Number that returned 3	4	5/6	Percent of the total return 3	4	5/6
1971	Lookingglass	52	327	17	13.1	82.6	4.3
1972	Lookingglass	30	223	24	10.8	80.5	8.7
1973	Lookingglass	10	233	23	3.8	87.6	8.6
1974	Lookingglass	6	64	5	8.0	85.3	6.7
1990	Rapid River	5	491	23	1.0	94.6	4.4
1991	Rapid River	113	154	95	31.2	42.5	26.3
1992	Rapid River	15	801	96	1.7	87.8	10.5
1992	Release	4	113	16	3.0	85.0	12.0
1993	Rapid River	22	326	672	2.1	32.0	65.9
1993	Release	3	12	84	3.0	12.1	84.9

a Lookingglass Creek stock age composition was summarized from Burck (1972, 1973, 1974, 1975). Rapid River stock age composition was summarized from Messmer et al. (1992, 1994). Release group was placed above the weir ans allowed to spawn naturally.

Appendix Table B-6. Age composition of chinook salmon that returned to Lookingglass Creek from the 1968, 1969, 1987, and 1988 cohorts.

Cohort year	Stock[a]	Age at return: Number that returned 3	4	5/6	Percent of the total return 3	4	5/6
1968	Lookingglass	52	223	23	17.5	75.8	7.7
1969	Lookingglass	30	233	5	11.2	86.9	1.9
1987	Rapid River	5	154	97	1.9	60.2	37.9
1988	Rapid River	113	801	672	7.1	50.5	42.4

a Lookingglass Creek stock age composition was summarized from Burck (1972, 1973, 1974, 1975). Rapid River stock age composition was summarized from Messmer et al. (1992, 1994, in press).